2001 Annual Report

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Introduction

R.J. Howard and S.F. Blade

The Crop Diversification Centres North and South (CDCN and CDCS) are research and development units of the Crop Diversification Division of Alberta Agriculture, Food and Rural Development (AAFRD). They focus on applied research and technology transfer in support of the horticulture, apiculture, special crop and forage seed industries in Alberta. The Centres' mandate of crop diversification and industry development is achieved through close partnerships with commodity organizations, grower groups, agribusinesses, university, federal and private sector researchers, agricultural colleges, and individual producers and processors.

This annual report covers the activities of staff in the New Crop Development, Horticulture, Forage, and Pest Prevention and Management Units located at CDCN and CDCS, as well as for the Food Science Program at CDCS, which is administered by the Food Processing Development Centre at Leduc. Only brief summaries of projects and trials carried out in 2001 are reported here. Please refer to the *Publications and Presentations* section of this report for sources of more detailed information.

The Horticulture Unit is responsible for programs dealing with potato, fruit, greenhouse, nursery and vegetable crops. The Unit also manages programs in plant pathology, entomology, micropropagation and market development, with specific responsibilities for the Vegetable Sales (Alberta) Act and Alberta Farmers' Market Program (until October, 2001). The Unit provides administrative and farm/shop support to staff in the New Crop Development, Forage, and Pest Prevention and Management Units at CDC South's headquarters at Brooks and at substations in southern Alberta, as well as to the Food Science Program based at Brooks. Unit staff also maintain the grounds, gardens and arboreta at the CDCS and CDCN.

The New Crop Development Unit is responsible for special crop research and development at CDCN and CDCS, as well as for plant pathology, weed science, post-harvest technology, and soil and water agronomy support to the Horticulture and Forage Units at CDCS. The Unit also includes an apiculture program based at CDCN, with a satellite office in Falher. It provides extension and regulatory services to the commercial beekeeping industry throughout Alberta. A Sustainable Woodlot Program was transferred to CDCN in 2001. It will encourage environmentally responsible management of native and planted woodlots throughout the province.

At CDCS, Forage Unit staff are involved in research and industry development related to forage and turf grass seed production, while staff in the Pest Prevention and Management Unit oversee the province's Dutch Elm Disease Prevention Program. The Food Science Program serves the research and extension needs of new and established food processors in Alberta, and it also provides valuable food processing and quality evaluation services to several horticulture and special crop research programs at the Centre.

Directors' Report

R.J. Howard and S.F. Blade

The year 2001 brought many challenges to the staff and programs at the Crop Diversification Centre North (located on the north-east edge of Edmonton) and the Crop Diversification Centre South (situated just east of Brooks). A severe drought gripped many parts of Alberta and affected the growth and profitability of Alberta's special crop, horticultural and forage industries. Nevertheless, the total farm gate receipts for diversified crops exceeded $500 million. The two Centres continued to address industry priorities in research and technology transfer. Partnerships with a variety of commodity organizations and government and non-government agencies saw over $0.5 million of externally funded projects carried out.

It was an exciting year at CDCN and CDCS as a number of new permanent staff were hired or took on new responsibilities. These included:

- Dr. Nicholas Savidov, joined the staff at CDCS as the Greenhouse Crops Research Scientist replacing Mr. Jim Calpas, who transferred to Edmonton to become the province's new Integrated Pest Management Specialist.
- Mrs. Janet Feddes-Calpas, head of the province's Dutch Elm Disease Prevention Program, also transferred from CDCS to Edmonton, where she continued her DED work and also became involved in managing the Purple Loosestrife Eradication Program.
- Mr. Wes Johnson, Vegetable Crops Technologist at CDCS, finished his B.Sc. degree at the University of Lethbridge and transferred to Edmonton to take over the vegetable technologist responsibilities at CDCN following the retirement of Ms. Cecilia McIsaac.
- Mr. Stewart Jangula was hired as the new Vegetable Crops Technologist at CDCS.
- Mr. Gerry Dames retired from his position as Welder and Mechanic at CDCN.
- Mr. Kris Pruski, Entomologist and Micropropagation Specialist at CDCN, successfully defended his thesis and was granted a Ph.D. degree from the Wageningen Agricultural University in the Netherlands.
- Mr. Muhammad Younus, Agrologist, left the Greenhouse Crops Program at CDCN to become a horticulture instructor at Olds College.
- Mrs. Cathy Feth resigned from the Potato Technologist position at CDCS.
- Ms. Lynda Ost transferred from CDCS to Beaverlodge to work as a Special Crops Technologist with Dr. Rachid El Hafid.
- Mr. Toso Bozic, Sustainable Woodlot Specialist, Regional Advisory Services - Northern Region, transferred from Barrhead to CDCN to facilitate AAFRD - industry partnerships in exploring the economic development of woodlots in the province.
- Ms. Janice McGregor, Rural Development Specialist (Business), Regional Advisory Services - Northern Region, transferred from Morinville to CDCN to work on the Regional Cuisine Project, which aims to promote the use of locally grown produce in the food service industry.
- Ms. Shelley Woods, Soil and Water Technologist at CDCS, continued her Ph.D. program at the University of Saskatchewan.
- Mrs. Elizabeth Russell, Special Crops Technologist at CDCS, began an educational leave with Dominion Herbal College, Burnaby, B.C., in the Consultant Herbalist Program.

CDCN and CDCS staff continued to work closely with other AAFRD staff and with colleagues from universities, agricultural colleges, other federal and provincial research organizations, and a wide variety of industry groups. They also organized and participated in numerous information sessions, workshops, field days, scientific conferences and tours in 2001. The Greenhouse Resource and Extension Assistance Team (GREAT) at CDCN was given a Group Achievement Award from AAFRD for their extraordinary work with the greenhouse industry.

CDCN celebrated it 50th Anniversary as a provincial government research station by hosting an open house on July 24, 2001. Over 500 staff and guests attended and participated in tours, dedications, gift presentations and related activities. The Honourable Lois Hole, Lieutenant Governor of Alberta, and the Honourable Shirley McClellan, Deputy Premier and Minister of Agriculture, Food and Rural Development, attended and offered congratulatory remarks.

The Industry Development Sector of AAFRD continued to proceed with a major reorganization aimed at meeting emerging needs in the agriculture and agri-food industry. Increased emphasis will be placed in areas such as entrepreneurship, innovation, business and value-added processing. The former Plant Industry Division was renamed the Crop Diversification Division, and Dr. Stan Blade was selected as the new Director. This Division will house the staff and programs at CDCS and CDCS. The restructuring will continue in 2002.

This Annual Report is a summary of ongoing research and extension programs. It represents the dedicated work of CDCN and CDCS staff who continue to play a major role in the development of the agriculture and agri-food industry in Alberta. Additional information on any program area, including detailed research reports, is available upon request.

Food Processing Development Centre

Food Science & Technology Program

Darcy Driedger, L.R.J. Dowdell, M. Hansen and C. McIntyre

The food science and technology program works to strengthen and expand Alberta's food and beverage industry by providing scientific and technical assistance. The program operates an analytical lab that is well equipped for the chemical analysis of a wide variety of agricultural and food-related products. It also maintains a product development lab used to develop food products and evaluate physical and sensory properties of foods. New pieces of equipment acquired this year include a juice/jam filler, several food-use pumps, a Brookfield viscometer and an Agilent 6890 gas chromatograph.

The program supports crop production research programs at CDCS by carrying out chemical analyses and sensory evaluations on new and existing cultivars of fruits, vegetables, potatoes, pulses, herbs and spices.

There was a large increase in the number of fee-for-service research contracts with the agri-food industry in 2001. These research projects generally had a narrow focus and immediate commercial application. The food science and technology program is associated with the Leduc Food Processing Development Centre and maintains the Centre's fee schedule and client confidentiality policies.

Research Projects

Most research initiated in 2001 was performed on contract and access to results is controlled by the client. However, the food science and technology program also provided analytical support to several publicly funded research projects headed by scientists from other programs and organizations.

Potato cultivar development

AAFRD participates in the Western Canadian Potato Breeding Program by conducting regional trials, disease resistance screening, storage trials, and processing and quality evaluations. All entries in the regional trials grown at CDCS were processed and evaluated for chipping qualities in the food product development lab. Many of the more promising lines were also evaluated for french fry, boiling and baking qualities. Total glycoalkaloid contents were determined for several lines as well. Data are forwarded to and maintained by Dr. Dermot Lynch (AAFC-Lethbridge), breeder for the Western Canadian Potato Breeding Program.

Fresh market potato quality

Dr. Michele Konschuh of the CDCS potato agronomy program conducted several trials that investigated quality issues related to fresh market potatoes. The food lab assisted in documenting the baking and boiling qualities of approximately 45 potato cultivars grown at CDCS. In another experiment, an instrumental method was developed to measure differences in red skin color among different cultivars and changes in skin color during storage.

Effect of cultivar on rhubarb juice quality

Eleven rhubarb cultivars were processed into juice using a small screw press. Yield, color, pH, acidity and soluble solids were measured. Color varied widely among cultivars. The juice study was only one aspect of a larger rhubarb experiment organized by Dr. Paul Ragan of the CDCS vegetable program.

Effect of cultivar on sweet corn sugar characteristics

The sugar composition of eight cultivars of sweet corn was evaluated by liquid chromatography as part of an experiment initiated by Dr. Paul Ragan of the CDCS vegetable program. Fructose and glucose levels were less than 1 per cent of kernel weight and sucrose levels ranged from 6 to 11 per cent of kernel weight. Super sweet (Sh_2) corn varieties had the highest total sugar concentrations. Corn kernel Brix readings tended to decrease as total sugar concentration increased.

Effect of variety and agronomic practices on essential oil composition

The food program determined the essential oil composition of numerous dill, coriander, and lavendar oil samples in support of research initiated by Dr. Manjula Bandara of the CDCS special crops program.

Technology Transfer Services

The food science and technology program initiated or participated in numerous research contracts with Alberta agri-food companies. These projects generally had immediate commercial applications and fell into the following categories:

- Bread quality evaluation
- Barley quality requirements for foreign distilled beverages
- Hay composition
- Processing potato quality
- Potato glycoalkaloid characterization
- Batter rheology
- Vitamin E in beef
- Glycerine residue on packaging and processing equipment
- Essential oil composition

Results from these projects were communicated directly to the client and are protected by confidentiality agreements.

In addition to contractual technology transfer activities, program staff also routinely receive telephone and email inquiries regarding food processing issues.

Forage Branch

Grass Seed and Forage Crops Program

H. Najda and A. Kruger

The grass seed and forage crops program at CDCS is part of the AAFRD Forage Branch. The program conducts agronomic and adaptability research to provide up-to-date information on grass seed production and traditional forage crops. New crop species and cultivars are submitted for testing by universities, provincial and federal research agencies and private industry from Canada, the United States and Europe. Research involving more than 100 irrigated and dryland experimental trials was conducted in southern Alberta including CDCS and the CDCS Bow Island substation.

Several trials were conducted in cooperation with other research institutions and agencies. These include the Forage Branch, Lacombe (forages), the Agronomy Unit, Edmonton (grass seed production), AAFC-Lacombe (forage corn) and ARC (grass seed production).

The following companies sponsored adaptability trials in 2001: ARC (AB); Brett-Young Seeds (MB); Cascade International Seeds (Oregon, USA); Cebeco International Seeds (Oregon, USA and Netherlands); Dawson Seed Co. (BC); Deutsche Saatveredelung (Germany); Lesco Inc. (Oregon, USA); Newfield Seeds (SK); Northstar Seed (MB); Parsons Seeds (ON); Pickseed (ON); Proven Seeds (AB); Scotts Co. (Oregon, USA), Tomorrow's Seed (BC) and Turf-Seed (Oregon, USA).

The program leader, H. Najda, provides information services to AAFRD staff and producer and commodity organizations. Details of research trials are presented in *Grass Seed and Forage Crops Program Annual Report 2001*, CDCS Pamphlet 2002-9.

Research Projects

Perennial Forage Crop Studies

Perennial grass seed production under irrigation

This has become a major area of research in southern Alberta. Many seed companies from Canada, United States and Europe are now contracting irrigated and dryland production acres in southern Alberta. Agronomy trials, companion cropping, fertility and seeding date trials on tall fescue and perennial ryegrass were conducted at Brooks and Bow Island. A new cooperative project to determine the effects of fall applied herbicides on different grass species grown for seed production was initiated in 2000. This program is part of a province-wide project lead by Dan Cole of the Agronomy Unit, Edmonton and is participating along with Calvin Yoder, Forage Specialist in the Peace.

In 1998 the Western Grass Seed Testing Program (WGST) was initiated to provide seed yield and adaptability information to the seed industry. The trials are coordinated by the grass seed and forage crops program at CDCS and are a cooperative effort including federal and western provincial research and extension staff and the seed industry. Testing sites are located at Fort St. John, BC; Beaverlodge, Bow Island, Brooks and Vegreville, AB; Melfort and Saskatoon, SK; Arborg and Portage La Prairie, MB. The grass seed and forage crops program at CDCS is responsible for seed acquisition and distribution to test cooperators and the production of an annual report for seed producers and the seed trade. Species currently being tested are Kentucky bluegrass, smooth bromegrass; chewings, creeping red, hard, meadow, mountain, slender and tall fescue; *Festolium*, orchard grass; intermediate, Italian and perennial ryegrass; timothy, intermediate wheatgrass and blue wildrye. Results of this program have led to increased contract seed production in southern Alberta especially of such grasses as tall fescue and Kentucky bluegrass.

Perennial forage variety testing

This was the eleventh production year of this province-wide program evaluating perennial forage species and varieties. This program is funded by AAFRD and coordinated by the Forage Branch, Lacombe. Species tested include alfalfa, alsike and red clover, bird's-foot trefoil, cicer milkvetch, Kentucky bluegrass, smooth and meadow bromegrass, orchard grass, Italian and Westerwolds ryegrass, timothy and crested wheatgrass.

The grass seed and forage crops program at CDCS is responsible for conducting irrigated and dryland trials at Bow Island and Brooks. The program is also responsible for compiling and analyzing data from all the provincial sites and preparing the annual report for the Alberta Forage Variety Committee (AFVC) of the Alberta Forage Council. This testing program allows producers to base crop decisions on information from a wide range of forage varieties. Data indicates there are significant differences in variety performance for the different agro-climatic areas of the province. Results of the trials are now available to the producer and industry personnel in the updated factsheet *Varieties of Perennial Hay and Pasture Crops for Alberta*. Agdex 120/32. This information is also available on the internet at the AAFRD site < http://www.agric.gov. ab.ca/navigation/ crops/forage/index.html>.

The Western Forage Testing Program (WFT) was initiated in 1995. This is a cooperative venture between Alberta, Saskatchewan and Manitoba which tests forage varieties for registration purposes. In most cases, enough location years are incorporated into the testing program to provide a basis for registration and to provide data for particular agro-climatic areas. In 2001, five alfalfa varieties and two timothy varieties were supported for registration by the AFVC.

Technology Transfer Services

The program leader, H. Najda, provided extension service to growers and industry personnel. In 2001, presentations were made at several industry and producer meetings and provincial advisory committees. Two information pamphlets on forage variety performance were updated and the information was posted on Ropin' the Web.

The program leader participated on the Forage Product Team, the Alberta Forage Variety Committee, the Alberta Alfalfa Seed Committee, the Western Grass Seed Testing Committee, the Western Forage Testing Committee, and the board of directors of the Chinook Applied Research Association. The program leader chairs the Lethbridge Community College Agricultural Technology Advisory Committee.

Horticulture Unit

Entomology Program

K. Ampong-Nyarko, K. Pruski, J. Motta

The goal of the entomology program is to develop functional integrated pest management (IPM) strategies to support the growth of crop diversification in Alberta. The applied research and development work of the program: promotes the reduction in pesticide use, enhances environmental stewardship, improves the ability of producers to manage pest risk and optimize crop productivity and profitability. The program also seeks to strengthen growers ability to adopt and implement IPM.

The program investigates ways to control insect pests and manage beneficial insects by developing new tools and control options based on pest ecology, economic thresholds and forecasting systems. Research is currently focused on IPM in vegetable, fruit, greenhouse and new crops. The program evaluates and adapts narrow-spectrum insecticides and biological control agents and offers a limited insect diagnostic service.

Research Projects

Fine-tuning integrated pest management strategy for root maggot fly in cole crops

This was the final year of project #98M220 IPM approach to control root maggots in cole crops. The aim of this study was to establish the benefits of crop rotation, calendar spraying, scouting-based spraying, economic injury level (three weeks after calendar spraying) and narrow spectrum insecticides on cabbage root maggot (*Delia radicum*).

The benefits of crop rotation as a tool for *D. radicum* management were confirmed, the number of root maggot eggs, at five weeks after transplanting cabbage, in the crop-rotated fields was reduced by 52 per cent compared to the fields continuously planted to cabbage for four years.

Lorsban treated plots had significantly higher marketable yield (39.3 t/ha) than Garlic Barrier, *Beauveria bassiana*, and Neem. The yield loss for the untreated control was 27 per cent. Three weeks after the application of the calendar sprays, the number of eggs in the scouting-based spray was 32 per cent lower than the calendar spray treatments. This may be an indication of disruption of beneficial insect activity by the pesticides. There was no significant difference in marketable yield between scouting-based spray (31.2 tons/ha) and calendar spray (30.4 t/ha). The delayed application has the potential of eliminating late pesticide applications by growers to control the second generation of *D. radicum*. This project was in collaboration with Vegetable Program at CDCN.

Studies in vector ecology of aster leafhopper (*Macrosteles quadrillneatus)* in Alberta

The objective of this project was to study aster leafhopper as a vector of aster yellows. The insects were studied in terms of spatial and temporal distribution in hope of understanding seasonal outbreak patterns and economic importance. The project is accumulating yield loss/disease incidence information and will do so over several years to develop predictive models and risk maps.

Preliminary field surveys in 2001 of carrot crops from 10 locations within the province indicated aster leafhopper was abundant in the province. The highest incidence of aster yellows was observed in fields located in Edmonton and the surrounding area. Disease incidence was lowest in Innisfail-Red Deer area. Nantes type carrots appeared to be the most susceptible to aster yellows infection.

A disease incidence yield loss study in the greenhouse was done. Carrot plants were infected by aster yellows very early in crop development (at four weeks after emergence) resulted in total crop kill. The per cent yield loss (y) and time of infestation (x, weeks after emergence) relationship was expressed by second order polynomial
$y = 100 - 5.2x - 0.114x^2$ $r^2 = 0.65$.

Use of biopesticide Neem in biologically intensive pest management in greenhouse crops

The objective was to develop and promote the use of the biopesticide Neem in a biologically intensive pest management system in the greenhouse and organically-grown horticultural crops. The first study evaluated efficacy of Neem and its various formulations for the control of whiteflys. The results indicated that Neem was as effective as the insecticide Actara in controlling whiteflys. The optimal application interval for Neem from the initial study is once a week. Neem was tested for residual toxicity to the biological control agents *Encarsia formosa*, a parasitic wasp and *Phytoseiulus persimilis*, a predatory mite. Neem and imidacloprid plus water, as a control, were applied to the plant foliage at typical label rates. At predetermined post treatment intervals (3, 8, 24 hours) *E. formosa* and *P. persimilis* was exposed to the treated foliage and observed. Neem was toxic to both test species at 3 hours after spraying but no insect mortality occurred at 8 and 24 hours. Imidacloprid was toxic to *E. formosa* and *P. persimilis* at all the observation times. This work is done in collaboration with greenhouse program at CDCN and Dr. Ken Fry at ARC.

Development of IPM for tarnished plant bug and western flower thrips in strawberries and saskatoons

The IPM project (#2000M605) is a collaborative activity between the entomology program at CDCN, AAFC-Kentville, AAFC-Lethbridge and ARC to control tarnished plant bug and thrips in strawberries in Alberta. Funds were received from industry sponsors and matched by AARI and MII.

The objective of the first study (completed within the year) was to establish the economic injury levels of tarnished plant bug *Lygus lineolaris* in saskatoon orchards. Treatments consisted of two stages of saskatoon fruiting (post full bloom to onset of ripening, post full bloom to ripening). Four densities of tarnished plant bugs (0, 1, 2, and 3) were introduced into caged branches. The tarnished plant bugs were allowed to feed on the fruit and leaves in the cages during the two treatment periods. The results indicate the number of tarnished plant bugs have a significant effect on number of mature fruit at harvest. Three tarnished plant bugs per branch reduced the number of mature fruit by 60 per cent, two by 43 per cent, and one by 27 per cent. Orchard surveys will be combined with the controlled yield loss studies to establish on-farm losses in saskatoon crops from tarnished plant bug.

In a second set of studies, narrow-spectrum insecticides were tested against western flower thrips and tarnished plant bugs in saskatoons and strawberries. Overall, best control of western flower thrips was achieved with Decis and Matador. Neem, Botanigard, Actara were promising and will be evaluated further. Excellent control was obtained with Decis, Matador, Actara and Neem against tarnished plant bug. Novaluron was ineffective against adult tarnished plant bug.

Technology Transfer Services

Information on IPM, root maggot, greenhouse pests, and general horticultural pests was shared with growers through grower calls, presentations at industry meetings, workshops and grower visits. General inquiries to specific grower concerns were answered and pest identification advice was provided to the public. In collaboration with Dr. Ken Fry, a pest identification workshop was organized for growers attending the Alberta Horticultural Congress.

Fruit Crops Program

L.G. Hausher and S. Dalpé

The fruit crop industry, a relatively new crop alternative, is expanding rapidly in Alberta.

The provincial fruit crops program conducts adaptation and agronomic research to support Alberta's developing and expanding berry and bush fruit industry. These studies may change from year to year depending on the requirements of the industry. Many new cultivars have been released which appear to provide increased production capability and quality; they are being investigated under Alberta conditions. Information generated from trials forms the basis of fruit crop recommendations provided to producers directly through producer organizations and AAFRD staff.

Strawberries, raspberries, saskatoons and black currants are the major crops assessed, although additional fruit crops are also evaluated for their commercial potential.

The majority of trials are conducted at the CDCS, with additional trials at CDCN.

Details of all research trials are reported in CDCS Pamphlet 2002-6 *Fruit Crop Trials 2001*.

Research Projects

Strawberries

Two Junebearing strawberry adaptation trials were conducted at CDCS and CDCN to obtain production, quality and adaptability information on various cultivars and selections. Advanced strawberry selections from the AAFC-Kentville, NS and St. Jean-sur-Richelieu, QC breeding programs were evaluated. The information provided to breeders will assist in varietal release decisions.

Studying new advanced selections also provides for accurate and valid producer recommendations once they are released. Additionally, several new varietal releases were evaluated against standard (recommended) cultivars.

Financial assistance from the Alberta Market Gardeners Association (AMGA) is appreciated and acknowledged in support of these strawberry cultivar trial evaluations.

A total of 42 cultivars and four selections were evaluated in the two trials. Differences in plant establishment and production of cultivars from two plant sources were also evaluated.

Raspberries

Eight new cultivars of floricane raspberries were grown and harvested to evaluate adaptability, production and quality information. Comparisons were made to three industry standard cultivars.

One new primocane cultivar was studied to find its acceptability and production potential in comparison to industry standards.

Saskatoons

Measurements made on the regrowth, plant health and fruit production of the two well-established saskatoon cultivar orchards. These orchards were rejuvenated in the spring of 1998 and 1999 by mowing to near the soil surface.

Many commercial saskatoon orchards are in need of rejuvenation, this information will provide techniques, orchard management and post-rejuvenation yield response recommendations. Orchards can be brought back to their productive capability in two years.

Black Currants

A black currant adaptation trial was carried out to obtain production, flowering and fruiting patterns, quality and adaptability information on 14 cultivars. Plant material was obtained from Ontario, British Columbia and Pennsylvania. Additional cultivars were established in 1999 with plant material obtained from Scotland.

An agronomic study with black currants consisted of evaluating pruning methods on four cultivars.

Financial assistance from the AMGA is appreciated and acknowledged in support of the black currant studies.

Gooseberries

Fifteen cultivars of gooseberries were evaluated to obtain production, quality and adaptability information. A feasibility study on gooseberry trellising was initiated.

Cherries

Mowing near ground level, in early spring 1999, regenerated Mongolian cherry and chokecherry orchards. The purpose was to evaluate regrowth and disease patterns in the orchards. In 2000, the rows were narrowed and regrowth measured. Although some flowering occurred in 2001, fruit set was extremely poor.

Evans sour cherry was fruited to establish yield potential.

Technology Transfer Services

The program leader, L. Hausher, provided extension services to producers, producer organizations and AAFRD staff.

Fruit Facts, a newsletter providing berry producers with up-to-date production and marketing information, was published monthly. Articles were prepared regularly for the AMGA and the Fruit Growers Society of Alberta (FGSA) newsletters. A commercial berry production school was conducted in Red Deer in February. Presentations were also made at the Fruit Production Workshop in Kananaskis in February and at numerous seminars.

Hausher continued as secretary and AAFRD representative to the Alberta Professional Horticultural Growers Congress and Foundation Society; the Alberta Horticultural Congress Foundation, The Horticultural Congress Planning Committee, The Alberta Society for Professional Horticultural Advancement and the AMGA.

Presentations were made to research, commodity and advisory groups during the year. Assistance was provided in the planning and running of the Alberta Horticultural Congress.

A black currant grower tour was organized in the Lethbridge area in July 2001.

Financial assistance from the AMGA made it possible for L. Hausher to attend the North American Berry Conference and 5th North American Strawberry (Research) Conference in Niagara Falls, January 2001; and also the North American Strawberry Growers Association summer tour, nursery and research farm visits, August 2001 in Nova Scotia.

Greenhouse Crops Program (Brooks)

J. Calpas, N. Savidov, P. Coté, S. Lisowski and L. Puchailo

New greenhouse scientist Nick Savidov assumed the responsibility of the program leader in September 2001. Despite of the change in the leadership the greenhouse crops program at the CDCS successfully served southern Alberta's diverse greenhouse vegetable and floriculture industry through comprehensive extension and research programs during the last year.

Research in new crop development, new technology and improved crop production techniques, are the main components driving the applied research program. The basic research program is directed towards reducing the negative environmental impacts of greenhouse crop production. Basic research is currently being conducted on the development of biological controls for *Botrytis cinerea, Pythium* spp. *Rhizoctonia solani* and *Fusarium* spp. in greenhouse crops.

Research undertaken by the greenhouse crops program has a strong market-driven focus, working with industry greenhouse produce marketers, to improve the entry of Alberta products into proven and developing markets across Canada and the U.S.

The program has identified market opportunities and has worked to improve the Alberta industry's access to these opportunities including cluster and beefsteak tomatoes, mini cucumber, and increasing market demand for greenhouse vegetables grown with reduced pesticide inputs.

Organic food is becoming a major priority for North American food market. The program initiated a long-term project aiming to develop an efficient technology for successful growing organic vegetables in Alberta greenhouses.

Research crops are grown to approximate commercial greenhouse crops and attain commercial levels of production. Program research projects target the distinct Alberta greenhouse growing environment and provide information on the best use of inputs and crop handling techniques specifically for Alberta conditions.

A number of trials are conducted in close association with grower organizations and industry partners. These include the Red Hat Cooperative, Air Liquide Canada, Westgro Horticultural Supplies Ltd., Biosphere Technologies, Cal Agri Products, LLC, C2C Zeolite Corporation and Applied Bio-nomics Ltd.. Trials are also conducted in cooperation with other AAFRD units, (Pest Management and Prevention) and provincial government agencies (Environmental Protection) as well as educational (the University of Alberta) and research institutions.

Research trial reports are presented in *Greenhouse Coverings*, the greenhouse crops program monthly newsletter, which is also available on the internet.

The program leader, N. Savidov, provides information and expertise to AAFRD staff, allied industries, financial institutions, community planners and to grower organizations.

Research Projects

Efficacy of precision placement carbon dioxide supplementation in greenhouse sweet pepper and beefsteak tomato production

The efficient use of carbon dioxide supplementation in Alberta greenhouse vegetable production represents a significant opportunity to increase yield.

The project is a cooperative effort between the greenhouse crops program, the Red Hat Cooperative and Air Liquide Canada. This was the forth year for the project.

The focus of the project was to design a carbon dioxide supplementation system to improve the distribution of carbon dioxide within the plant canopy and define the parameters that allow for cost-effective carbon dioxide supplementation under southern Alberta greenhouse growing conditions.

A significant yield increase in sweet peppers represents an unprecedented increase in yield potential for Alberta growers. The results of this year consistently reproduced the effect of carbon dioxide observed in previous years.

Development of a biological control for *Botrytis* in greenhouse tomato

The greenhouse crops program has a long-standing commitment to biological controls. Research vegetable crops have been grown without the use of pesticides for seven years. This commitment reflects the overall commitment of the Alberta greenhouse industry towards the use of biological control agents for greenhouse pests.

In addition, developmental work on biological control agents for common greenhouse diseases has been ongoing over the past year. Work has primarily targeted the gray mold pathogen, *Botrytis cinerea*, using Alberta isolates of *Trichoderma* spp., a fungal genus known for its activity against disease-causing fungi.

This research project is now complete and the final report is in progress.

The bulk of funding for the *Botrytis* project was provided by AARI.

Application of genetic fingerprinting technology

Through the biological control program the greenhouse crops program has developed considerable expertise in the genetic fingerprinting of fungi and other organisms. Two independent projects initiated in 1999 were completed this year. One new project, initiated in 2000, on the genetic characterization of fungicide resistant strains of *Alternaria solani*, the early blight of potato pathogen was also completed. These projects were in cooperation with Pest Management and Prevention Unit AAFRD, and the Department of Environmental Protection. The objectives of the beetle projects were to develop rapid DNA-based identification procedures for the European elm bark beetle and the mountain pine beetle which could be used on partial specimens and to determine whether individual beetles could be identified with respect to "regional" parent populations of the beetles. The objective of the *A. solani* project was to determine if the RAPD-PCR procedure could be used to identify differences in Alberta *A. solani* isolates could help explain the increased incidence of early blight in Alberta potato fields.

Development of crop diversification opportunities for Alberta greenhouse growers

The greenhouse crop program responded to growing market demands by testing cultivars of mini cucumbers including Harmony, Kian, Alamir and Melita. All cultivars were successfully grown hydroponically. Three cultivars including Kian, Alamir and Melita produced similar yields. Several cultivars of heirloom tomatoes including Black Russian, Brandy Wine, Pink Grapefruit, Sub-Arctic Plenty, Ligerella and Roma were tested as prospectives for the Alberta's vegetable market. The program continued testing of different poinsettia cultivars. Work with cut flower focused on determining the cultural requirements and performance of Physotegia (obedient plant), Lysimachia (gooseneck loosestrife) and Chinese cultivars of Lysianthus.

These trials will continue into 2002-2003.

Development of new technology based on application of zeolites

A new project was initiated using of zeolite (clinoptilolite) in greenhouse vegetable production. Zeolites, natural absorbents, were discovered in the later half of 20th century. The unique qualities of zeolite, also known as "magic rock" allow its numerous applications in industry. This project moves the greenhouse program to a leading position in Canada and North America in zeolite application in agriculture. Zeolites improve stability, water retaining and ion exchange capacities of plant substrates currently in commercial use. The objective is to develop better greenhouse substrates, which will lower the probability of diseases and nutrient disorders and raise the yield of greenhouse vegetables at a lower production cost; improving profit margins and market opportunities for Alberta greenhouse growers.

Efficacy of a new organic fertilizer MBM for greenhouse production of organic vegetables

Meat bone meal (MBM) is a new organic fertilizer produced from the waste of livestock industry using technology developed by an Alberta-based company, Biosphere Technologies Inc. MBM is a valuable source of nitrogen for crops. This fertilizer has an important potential for the development of organic farming in Alberta and growing organic food market due to high nitrogen and phosphorous content and large size of livestock industry in Alberta.

Technology Transfer Services

The program leaders, J. Calpas and N. Savidov, provided extension service to growers and department and industry personnel. Telephone and on-site consultations with greenhouse growers regarding crop management concerns make up a large part of the extension activities. Transferring crop production expertise regarding new crops and improved production techniques and technology is also a strong component of the extension service.

Several presentations were delivered at industry and producer meetings.

The program leaders also provided information to other AAFRD staff; Rural Development Specialists and Marketing Specialists, as well as departmental committees and the Horticultural Product Team. Consultations with loan officers with private banks and the Agriculture Financial Services Corporation are also routine.

The greenhouse crops program also has a grower training program, which provides hands-on crop management and production training to individuals interested in becoming commercial growers. This program has produced growers who have gone on to become established owner/operators of successful commercial greenhouse businesses.

Calpas continued as a full-time student in a Ph.D. program through the University of Alberta.

Greenhouse Crops Program (Edmonton)

M. Mirza, M. Younus and W. Chen

The greenhouse crops program at CDCN provides research and technology services to clients in central and northern Alberta. Research is based on input from the Alberta Greenhouse Growers Association (AGGA) and is conducted in partnership with CDCS, ARC and greenhouse growers. The AGGA completed an industry survey in 2000 and the final report was made available in 2001. Copies can be obtained by visiting AGGA website <www.agga.ca>. During 2000-2001 growing season, growers had to contend with the high price of natural gas. The government administered two programs to stabilize the price. One was the Farm Income Assistance Program (FIAP) and the other was a rebate of $0.40/sq. ft. on the greenhouse space. Greenhouse program staff provided help to administer this program. Three hundred and eighty growers benefited from this program. During 2001-2002 season the price of natural gas was lower. One rose grower installed a co-generation system to generate power for lighting and use waste heat to heat the greenhouse. Five growers are using coal as a fuel for greenhouse heating.

Many growers diversified into the production of vegetables like mini and mid-size cucumbers, eggplants, purple colored peppers and strawberries. *Pythium* caused a significant yield loss in cucumbers; the decomposing sawdust in second crop in May appeared to be the major reason. Growers more commonly used biological controls.

Research Projects

Evaluation of *Paenibacillius polymyxa* PKB1 for biocontrol of *Pythium* in cucumbers in recycling hydroponic system

In cooperation with J. Yang and P.D. Kharbanda, ARC, studies were continued for a third year to evaluate the ability of *Paenibacillius polymyxa* PKB1 to protect cucumber plants against *Pythium* in total recycling nutrient system. In this study, the data was collected on disease severity of root, plant growth rate, water consumption and total yield. The results indicate that *P. Polymyxa* PKB1 protected plants from natural infections of *Pythium* and the yield was significantly higher (5 per cent probability) when compared between the control and plants inoculated with PKB1. Water use by the plants

provided an additional parameter of root health. Water consumption was significantly reduced in plants inoculated with *Pythium* when compared to PKB1 treated plants. There was also a significantly positive correlation ($R^2 = 0.8438$) between water consumption and total fruit yield.

Evaluation of organic fertilizers for the production of Echinacea

This is the second year of study. *Echinacea angustifolia*, *E. pallida* and *E. purpurea* were grown in a commercial soilless medium which was either topdressed with an organic fertilizer, 6-2-4, or fertigated with Fish-Agra 4-1-1 or a traditional inorganic complete fertilizer. Each fertilizer treatment was replicated four times with 10 plants in each replicate. The plants were grown for seven months, then fresh and dry root weights were determined. There was no significant difference (5 per cent probability) between the treatments; this shows organic fertilizers tested were as effective as the inorganic fertilizer. The data on echinacoside content is not available at this time.

Effect of three levels of phosphorus fertilization on the growth of white spruce seedlings

In February, white spruce seedlings germinated in 112 size styroblocks in a commercial soilless growing medium were irrigated with a complete nutrient solution containing 5, 20 or 50 ppm of phosphorus. Each treatment was replicated three times with 112 seedlings in each replicate. The data on fresh and dry weight of roots and shoots, stem caliper and height were collected in mid November. Results indicated the seedlings receiving a nutrient solution with 50 ppm of phosphorus had a significantly higher (5 per cent probability) shoot dry weight and root dry weight, stem caliper and height when compared to seedlings receiving the other treatments.

Further observations on the production of Gotu Kola (*Hydrocotyle asiatica*) in greenhouses

Large-scale production of Gotu Kola (*Hydrocotyle asiatica*) was studied using a total bench space of 7 m^2. Rooted plugs were planted in early February and leaves were harvested the last week of May, first week of August and October. A yield of 40.5 kg/m^2 fresh weight and dry weight of 5 kg/m^2 was obtained. In another trial, a floating system was used with only nutrient solution in root zone. A yield of 27 kg/m^2 fresh weight and a dry weight of 3.78 kg/m^2 was obtained from this system. Data on the active ingredient, asciaticosides is not available at time of publishing.

Production of Burdock (*Arctium lappa*) in greenhouses

Observations continued on two-year-old burdock (*Arctium lappa*) plants for root development. During the winter the tops were removed; in March the plants were activated by increasing the temperature. Plants were dug in September and data on roots fresh and dry weights was recorded. Average fresh weight was 567 grams/plant and dry weight was 147 grams/plant at a density of 50 plants/m^2. The root weight almost doubled in the second year compared to the first year harvest. In an aeroponic system the fresh weight was 180 grams and dry weight was 34 grams/plant at similar density.

Production of Angelica (*Angelica archangelica*) in greenhouses

A crop of angelica (*Angelica archangelica*) was planted in a commercial soilless medium using 30 cm deep troughs the third week of May and harvested the end of October. An average root fresh weight was 59.5 grams/plant and dry weight was 14.8 grams/plant. The root to shoot ratio was 1:1. The plants were very susceptible to western flower thrips and aphids.

Comparison of nutrient status of growing media and plants in ten bedding plants species

Growing media and tissue was analysed for nutrient contents of ten bedding plant species from three commercial greenhouses. The bedding plants included alyssum, begonia, impatiens, lobelia, marigold, million bells, osteospermum, pansy, petunia and snapdragon.

The results showed a wide variation in the nutrient contents in the growing medium and the plant tissue. In the growing media, ammonium nitrogen, phosphates and sulfates were in the extremely high range. Boron and manganese were in the toxic range especially when the pH was close to 5.5. In the tissue, high levels of nitrogen, manganese and sulfur were observed while copper was found on the low side with potential deficiency in some cases. This study will be used to develop nutrient management recommendations for bedding plant growers.

Technology Transfer Services

Greenhouse planning and production information was provided to more than 250 growers. The information on crop management was provided through workshops and field day. Six issues of greenhouse coverings were published and four publications were updated. M. Mirza was a guest speaker at the Saskatchewan Greenhouse Growers Conference in November 2001. Pest Advisory Notes (PAN) were prepared for bedding plant growers and poinsettia growers based on a need from growers. PAN was posted on the AGGA website and AAFRD website and faxed to the growers. The Greenhouse Resource and Extension Assistance Team (GREAT) was awarded a Group Achievement Award by AAFRD in recognition of service excellence through teamwork. This team conducted workshops for the greenhouse industry and delivered several talks at the Alberta Horticultural Congress held in November in Edmonton.

Nursery Crops Program

C.L. Murray, N.G. Seymour and T.T. Pheh

The nursery crops program is focused on research into cultural management practices for commercial nursery production of both field and container-grown plants and the evaluation of new plant cultivars. Technology transfer activities included seminar presentations, magazine articles and research reports directed to growers and other members of the nursery-landscape trades industry as well as potential growers. A close association with Landscape Alberta Nursery Trades Association (LANTA) allows for excellent communication with the commercial industry.

C.L. Murray, program leader and N.G. Seymour, nursery crops technologist are based out of CDCS and T.T. Pheh, nursery crops technologist is based out of the CDCN.

The program leader also provides information services to other AAFRD staff and to producer and commodity organizations. Details of research trials are presented in *Nursery Crops Program 2000*, CDCS Pamphlet 2001-8.

Research Projects

Woody Plant Evaluation Trials

Prairie regional trials — CDCS and CDCN

The Prairie Regional Trials (PRT) were established in 1958 to evaluate the hardiness of woody plants on the Canadian Prairies and continue today in cooperation with AAFC-Morden in Manitoba. The plants in the PRT are evaluated for five years at eight prairie sites including CDCS and CDCN. The growth and landscape quality data collected each year are sent to Morden where a report is produced approximately every three years and is now available at the internet website <http://res2.agr.ca/winnipeg/prt59_58.html>. In 2000, nine new selections were planted at CDCN and three new rose selections at CDCS.

Regional woody plant test program — CDCS AND CDCN

Since 1983, AAFRD staff, the LANTA Growers Group and Research Committees have cooperated to develop and maintain The Regional Woody Plant Test Program (RWPTP). New tree and shrub introductions, generally from North America, are evaluated for five years at seven different sites representing different climatic regions in the province. Growth and landscape quality data are collected each year. Seven new selections were planted at each site in 2001.

For more information about the RWPTP from 1983-2000 see *Regional Woody Plant Test Project, Summary Report 2000, CDCS Pamphlet #2001-3* or on the internet at <http://www.agric.gov.ab.ca/crops/trees/rwptp/index.html>.

The University of British Columbia plant introduction program — CDCS

The University of British Columbia (UBC) Botanic Garden Plant Introduction Program selects superior plant material from many sources to test for suitability for introduction into the nursery-landscape industry. In 1998, the UBC selection, *Lonicera* 'Son of Mandarin', began evaluation at CDCS. For more information on the UBC program go to <http://www.hedgerows.com/UBCBotGdn/UBCResearch.html>.

The perennial trial garden at the Calgary Zoo

In response to the huge growth in interest and sales of herbaceous perennials, the Calgary Zoo and Botanic Garden, LANTA Retail Operators Commodity Group and CDCS cooperated to develop the perennial demonstration and evaluation garden from 1999-2001. The project is now complete. The garden was located at the Calgary Zoo in the Dorothy Harvie Gardens. The project objectives were: 1) to evaluate new species and cultivars of perennials for hardiness and landscape quality under Chinook conditions; 2) to compile and publish the results for the public, retailers, growers and landscape professionals; 3) to increase the knowledge about new perennials for the public, retailers, growers and landscape professionals; 4) to provide a unique work experience at a public garden for a horticulture student.

The summary of the data collected over three seasons has been published in the technical document, *Perennial Trial Garden Evaluation 1999-2001*, and a general audience brochure. Both are available from the LANTA Retail Operators Commodity Group.

All-America selections — CDCS

All-America Selections is a non-profit organization dedicated to promoting the development and introduction of improved cultivars of flowers and vegetables. The CDCS location is one of the approximately 35 trial sites in North America. The results of the evaluations from all the sites are tabulated and the best selections are released 18 months later. In 2001, eight new selections were evaluated.

Bur oak provenance trial — CDCN

The Bur Oak Provenance Trial is a cooperative trial originally organized by the Great Plains Agricultural Council, Forestry Committee and is coordinated in Canada by the Prairie Farm Rehabilitation Administration (PFRA) Shelterbelt Centre, Indian Head, Saskatchewan. The objectives of the project are: 1) to determine the nature and extent of bur oak genetic variation; 2) to provide genetically improved bur oak seed for shelterbelt planting; 3) to provide germplasm that can be used for selection and trait improvement as well as advanced-generation breeding; and 4) to survey the distribution and impact on seed quality of *Curculio* spp. (acorn weevil). The project began in 1993 and is expected to run for approximately 20 years. There are 48 accessions in the trial collected from the following locations: Manitoba (19), Saskatchewan (4), Minnesota (4), Montana (3), North Dakota (16), South Dakota (2).

Vineland apple rootstock trial — CDCN

The Vineland Apple Rootstock Trial is a cooperative trial with the University of Guelph, Horticultural Experiment Station, Simcoe, Ontario. The trial is evaluating the cold hardiness of the "V" series of rootstocks. There are currently four selections for the control (Ottawa 3, M9, Beautiful Arcade, Columbia) and five new selections bred at the Simcoe Station. The trees were planted in 1997 and will be on trial for five years.

Production Management Research Projects

Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates — CDCN and CDCS

Field-grown plant material is the largest segment of the nursery industry in Alberta. There is inadequate information about the management of fertility for maximum tree growth in the short Alberta growing season, while avoiding over fertilization which may result in winter kill or dieback of trees. Colorado blue spruce seedlings and Summit (Edmonton) and Patmore (Brooks) green ash were planted on an unirrigated site in Edmonton and an irrigated site near Brooks and grown at four soil nitrogen (N) levels: control (no added fertilizer), 50, 90 and 130 kg N/ha.

There were no significant differences in tree caliper increase for spruce and ash in 1997, 1998, 1999 or 2000, except for three occasions: spruce 1997 in Brooks where caliper change was greater in the control and at 50 than at 130 kg N/ha, spruce 2000 in Edmonton where caliper change was greater at 50 kg N/ha than the control and ash in 1999 in Edmonton, where caliper change was greater at 50 and 130 than at 90 kg N/ha. Caliper change data was collected in Brooks in 2001 but there were no significant differences for ash or spruce in that year. Tissue N content was not different for ash in 1998, 1999, 2000 or spruce in 1998 or 1999. In 2000 spruce tissue N was greatest at 90 kg N/ha.

Evaluation of the effect of IBA concentration, timing and juvenility on rooting efficiency for cuttings of five species of woody plants — CDCN

A number of species of shrubs are considered by growers to be difficult-to-root using softwood cuttings; this limits their availability in the marketplace and increases the cost of production of these species. The literature indicates that some hard-to-root woody plants have better rooting efficiency when the cuttings are collected from juvenile plant material. Juvenile cuttings were collected from mature plants cut down to ground level in early May 2001 then allowed to re-grow.

Cuttings of new green shoots were collected on three dates from mature Saskatoon, pin cherry, Royal Purple lilac and Chickadee birch. Saskatoons rooted more often at 12 and 26 June and when they were collected from juvenile plant material. Lilac rooted better on 7 June than earlier or later dates and when cuttings were collected from juvenile plants. Pin cherry cuttings rooted to a greater degree when collected from juvenile plant material and there was no differences among cutting dates. The Chickadee birch rooted at 36.5% on 5 July, the best rooting recorded of all dates.

Hardwood cuttings of Seabuckthorn were collected in March, frozen, then stuck in media in June. Cuttings were then placed in either the greenhouse or lathhouse. Rooting was generally greater for cuttings placed in the lathhouse and there was no difference in rooting between cuttings treated with 0.8% IBA and those not treated.

An investigation of the impact of high rates of sulphur on the medium pH of container-grown woody plants — CDCS

Rooted cuttings of Goldflame spiraea were grown in #2 containers with three sulphur products: elemental sulphur (0-0-0-95), Tiger 70 (6-0-0-70) and Tiger 90 (0-0-0-90) incorporated into the container medium at four rates: 3.6, 5.4, 7.2 or 10.8 kg/m^3. Plants in the control treatment had no sulphur added to the medium.

There were no significant differences in plant dry weight as a result of the different sulphur treatment. The pH of the media was highest at 10.8 kg S/m^3 with elemental S and Tiger 90 and lowest at Tiger 70 at 3.6 kg S/m^3 and Tiger 90 at 7.2 kg S/m^3.

Measuring temperature fluctuations of container-grown woody plants under poly-blankets— CDCS

The root systems of many container-grown plants will survive to –8°C; thus, the blanket must provide adequate protection from the cold and also minimize temperature fluctuations, which can also lead to tissue dieback. The temperature of the container media was measured in two containers stacked to 1.2 m and completely covered for the winter with two blankets made with a poly cover and a layer of microfoam insulation.

Thermocouples were inserted into the potting medium of containers in the north, south, east, west, top and bottom of the pile. The temperature of the air inside the pile and the air outside the pile was also measured. There were minor fluctuations in daily average temperatures inside the pots with the lowest temperatures, about –5°C, recorded in pots on the north side in late February. In April, the temperature in pots on the south and top sides fluctuated more than other pots, rising as high as about 10°C on April 7. The container piles were uncovered April 10.

Plant collections CDCS and CDCN

Plant collections have been developed and maintained at both CDCS and CDCN as a living reference collection for use by horticultural professionals and the general public. The **Golden Prairie Arboretum** was established in 1981 at CDCS. The collection now contains 312 species of 68 genera for a total of 531 deciduous trees and shrubs. These plants represent most of the deciduous woody plant species that can be grown on the prairies. A complete listing of the collection is available in *Golden Prairie Arboretum, ASCHRC Pamphlet 93-1.* The **Forever Green Pinetum** collection of coniferous trees and shrubs at CDCS was established in 1986. At present it contains 26 species of nine genera for a total of 120 trees and shrubs. A complete listing of the collection is available in *Forever Green Pinetum, ASCHRC Pamphlet 93-12.* The **Rose Garden** contains 241 specimens, many of which are unique to the CDCS collection. Many early Canadian rose cultivars and notable crosses of Canadian rose breeders, Skinner, Bugnet and Wallace are maintained in the collection. At CDCN, the **McCalla Arboretum** has 192 taxa on display and is being redesigned as a lower maintenance landscape.

Technology Transfer Services

Technology transfer to the growers is accomplished through work with the LANTA Growers Group, Western Nursery Growers Group, nursery visits as well as by the production and distribution of the Nursery Crops Trial Report, magazine articles and the presentation of seminars. In 2001, the nursery crops leader presented a seminar on research at the Alberta Horticulture Congress. Also the leader traveled with the Western Nursery Growers Group to tour nurseries, garden centres and research facilities in the Montreal and Quebec City areas.

Plant Pathology Program

P.S. Bains, H. Bennypaul, K. Kumar, and M. Yu

Plant diseases cause economic losses by reducing yield and quality, and are known to cast a strong negative influence on the reputation of an industry. The objectives of the plant pathology program at CDCN are to assist in the production of high quality raw and value-added products for maximum economic returns, growth, and sustainability of the Alberta horticultural and new crops industries. These objectives are achieved by reducing the losses caused by various plant diseases through research and technology transfer.

The program develops research projects in consultation with the industry and conducts research on these projects in cooperation with researchers from AAFRD and other research institutes. The program has been successful obtaining research funds for many of these projects from private and government agencies. The program has published many research papers in refereed and non-refereed journals, research reports, and articles in industry and government newsletters. Results of various research projects have also appeared in newspapers, magazines and in media interviews.

Research Projects

Cytospora dieback and canker of saskatoon (*Cytospora leucostoma*)

This research project is funded by Fruit Growers Society of Alberta, Alberta Horticultural Congress and AARI and is in cooperation with Dr. R.J. Howard, CDCS.

Cytospora dieback and canker disease of saskatoon, caused by *Cytospora leucostoma*, is one of the most devastating diseases of saskatoon. If unchecked, the disease, under favorable conditions, could cause complete destruction of an orchard in five to seven years. The disease is common in Alberta and no fungicide is registered for its control. In 2001, field experiments were conducted to evaluate the efficacy of selected fungicides in reducing the incidence of Cytospora infection on saskatoon bushes. The experiment was conducted in a commercial saskatoon orchard in DeWinton, Alberta.

New shoots were injured, tagged and sprayed with chlorothalonil, propiconazole, thiophanate-methyl or water. Two weeks after spraying the fungicides the shoots were removed and surface sterilized. The infection was monitored by plating out tissues from injured areas and observing growth of *C. leucostoma* colonies.

This was done four times in May, June, July and August. Chlorothalonil was most effective in reducing the infection; propiconazole was the second. Previously, research indicated that chlorothalonil and propiconazole cause complete inhibition of *in vitro* growth of *C. leucostoma* and significantly inhibit infection of detached saskatoon shoots. Both chlorothalonil and propiconazole have been reported to inhibit the development of entomosporium leaf and berry spot of saskatoon; only propiconazole is registered for control of this disease.

Field evaluation of pre-plant seed treatment fungicides on development of fusarium dry rot in potato seed tubers

This project is funded by Syngenta Crop Protection Canada, Inc.

Fludioxonil (Maxim) alone or in combination with mancozeb or mancozeb + difenoconazole (Dividend) completely inhibited the development of dry rot in mother tubers. Mancozeb (Tuberseal) was also effective in reducing both the incidence and severity of the disease. Whereas, thiophanate-methyl (Senator) and thiabendazole (Mertect) treatments increased the severity of the disease compared to that of the inoculated control. One of the two other experimental fungicides (Gustafson) was also effective in reducing dry rot development in seed tubers.

Echinacea seed infection studies

Large percentage of echinacea seeds was infected with *Alternaria* or *Fusarium* spp. The results of experiments conducted using echinacea seed with or without seed coat and surface sterilization indicated that seed coat is the major source of infection. Hot water treatment was not very effective in eradicating this infection. Soaking the seeds in water followed by an anaerobic treatment was effective in controlling fungal pathogens, had no effect on germination but it encouraged bacterial growth. The bacterial growth's effect on the seedling infection is not evaluated yet. Eight fungicides were evaluated for their effect on radial growth and spore germination of single spore isolates the *Alternaria* and the *Fusarium* spp.

Fludioxonil at 1 and propiconazole at 10 ppm caused 90 per cent inhibition of the radial growth of the *Fusarium* sp. and chlorothalonil and fludioxonil at 1 ppm caused complete inhibition of the spore germination of the pathogen. Mancozeb and metiram at 10 ppm were effective in reducing the germination to 10 per cent of the control. Fludioxonil at 1ppm reduced the *in vitro* radial growth of the *Alternaria* sp. to 10% and propiconazole at 10 ppm to 20 per cent of the control. Spore germination of the *Alternaria* sp. was inhibited to 10 per cent of the control by 1 ppm of fludioxonil or 10 ppm of chlorothalonil.

Early Blight Project

This research project is funded by Potato Growers of Alberta and AARI. The cooperators on the project include Dr. J.D. Holley and Mr. J. Calpas.

Comparative susceptibility of potato cultivars to Alternaria solani — Results of data of cultivar susceptibility in 1999, 2000 and 2001 indicate that potato cultivars differ in their susceptibilities to *A. solani*. Norland, Rode Eerstling, Russet Norkotah were comparatively more susceptible than Rode Star, Russet Burbank, Chipeta and Alpha. In general, the cultivars showed similar comparative reactions. Cultivar susceptibility experiment results from three sites in southern Alberta also showed Norland to be significantly more susceptible than Russet Burbank and Shepody.

Comparative virulences of Alberta isolates of Alternaria solani — Twenty-eight Alberta isolates of *A. solani* were evaluated for their comparative virulence on potato leaves. Mean lesion diameter ranged from 50.4 mm for isolate GV2-3 to 17.4 for isolate S39-1. Difference in comparative virulence among the isolates could account for some of the observed differences in disease development under similar conditions. In last year's experiment it was argued that the differences in the virulence could be due to a different number of viable spores present in the inoculum of different isolates. In this experiment, similar concentrations of viable spores for each isolate were used, the results suggested that the differences are due to inherent characteristics of the isolates.

Genetic characterization of Alberta isolates of Alternaria solani — Thirty-one Alberta isolates of *A. solani* were differentiated by PCR based Random Amplified Polymorphic DNA (RAPD) analysis. There was a high degree of similarity among the isolates. Twenty-eight of the 31 isolates being approximately 30 per cent dissimilar with no clear groupings among the isolates. The remaining three HB10-4, NM2-3 and BT2-1 were approximately 50, 66 and 83 per cent dissimilar, respectively, from the main group. These were also very different from each other. The four phenogram groups did not correspond to chlorothalonil, metiram or mancozeb sensitivity groupings, comparative virulence differences among the isolates or to the geographic location of the isolate. The only characteristic common to the three isolates is that these are poor sporulators in culture. However, not all poor sporulators were distinguished by the analysis. Initially, the primers were selected based on sensitivity to chlorothalonil. However, more information on differences in comparative virulence among the isolates has become available. It might be useful to reexamine the isolates based on differences in virulences.

Reactions of potato cultivars and breeding selections to various pathogens

Large number of potato cultivars and breeding selections were evaluated for their field reaction to natural inoculum of *Rhizoctonia solani* and *Helminthosporium solani*. The cultivars/breeding lines differed widely in their susceptibility to *H. solani*, the cause

of silver scurf of potato. The differences were observed both in the development of, incidence and severity of the disease. The disease severity index was calculated from the incidence and severity values. Yukon Gold, VO391-4, Irish Cobbler and Norvalley were significantly more susceptible to the natural inoculum of the pathogen than Banana, Sangre, Glacier Chip, FV9633-6, Snowden and Umatilla. Other breeding selections (FV10459-8, VO299-4, CV88014-11, VO168-3, VO498-9) from the AAFC-Lethbridge Potato Breeding Program were in the middle of the susceptibility/resistant spectrum. None of the cultivars/breeding selections showed complete resistance to the pathogen.

Potato cultivars/breeding lines differed widely in their susceptibility to *R. solani*, the cause of stem canker and black scurf of potato. The differences were observed both in the development of incidence and severity of the disease, and disease severity index calculated from the incidence and severity values. Norvalley, Mondial and Bintje were comparatively more resistant to the pathogen than Norland, Russet Burbank, FV9633-6, VO299-4 and Nordonna. Other breeding selections (VO498-9, VO391-4, VO168-3, CV88014-11, FV10459-8) from the AAFC-Lethbridge Potato Breeding Program were in the middle of the susceptibility/resistant spectrum. None of the cultivars/breeding selections showed complete resistance to the pathogen.

Reaction of breeding lines of peas to ascochyta blight

Mycosphaerella blight or ascochyta blight, caused by *Mycosphaerella pinodes* (imperfect stage: *Ascochyta pinodes*) is the most devastating disease of peas in western Canada. Comparative susceptibility of 84 breeding selections to natural inoculum of *A. pinodes* was determined by examining the development of the disease on 100 pea stems in each of the four replicated plots for every breeding selection. The selections showed a continuum range of blight reaction to the pathogen. None of the selections were completely resistant, in general, the majority of the selections had a susceptible to highly susceptible reaction. In the first set of 40 selections, Radley F25-18 developed a significantly less susceptible reaction to *A. pinodes* than that of eleven other selections. Similarly, in the second set of 44 breeding selections, five of the selections were comparatively less susceptible to the pathogen than 26 other selections. Ascochyta blight susceptibility was one of the criteria for graduating a breeding selection to the next level. Reaction of the graduating selections will be evaluated in the following years. It is anticipated that increased disease resistance will enhance performance of field pea cultivars in western Canada.

Late blight of potatoes

A total of 35 potato fields in central and north central Alberta were surveyed for late blight of potatoes. From the large number of samples collected from these fields, three were infected with the late blight pathogen, *Phytophthora infestans*. The growers were immediately informed about the presence of the disease and suitable control measures. The growers took immediate steps to contain the disease. A fourth positive sample from a garden was brought in by a grower. Limited number of tuber tests for late blight infection were conducted on seed lots for export to USA.

Technology Transfer Services

Technology transfer is achieved through presenting information at industry meetings, holding workshops, writing articles in extension publications, through telephone, internet and farm visits. The program leader attended many industry and scientific meetings and workshops including annual, area and breakfast meetings of PGA, Potato Team and other potato industry meetings, Alberta Horticultural Congress, Growing Global, Organic and New Crop Opportunities, Western Committee on Plant Diseases, annual meeting of the Canadian Phytopathological Society, annual meeting of the Plant Pathology Society of Alberta and Novartis Potato Seminar.

In 2001, P.S. Bains was awarded "Group Achievement Award" for Greenhouse Resource and Extension Assistance Team. Plant pathology program acknowledges the contribution of Kiron Jhass and Brenda Reiter.

Potato Agronomy Research Program

M. Konschuh, M. Nielsen and Angela Spencer

The objectives of the potato program are to foster increased production efficiency and competitiveness of the potato industry in Alberta and the sustained industry growth and development. Research objectives include applied research in the areas of crop rotation, nutrient management, tuber initiation and tuber set control, seed physiology, plant populations and seed piece management. New information on potato agronomy is packaged and transferred to Alberta's potato producers, packers and processors.

AAFRD participates in the Western Canadian Potato Breeding Program by conducting regional trials, disease resistance screening, storage trials and processing and quality evaluations. The primary objective of the breeding program is to select improved potato varieties adapted to the southern prairies.

Varieties needed by the industry include: a chipping variety that is more stable in long-term storage; an early chipping variety that will yield well and chip by the third week in July; an attractive fresh-market red potato that holds color in long-term storage; a maincrop, fresh-market and french fry potato that is earlier than Russet Burbank and has better quality. The program is managed by potato breeder Dr. Dermot Lynch, AAFC-Lethbridge, who makes crosses and evaluates preliminary selections at the Vauxhall substation. Final testing is done at the regional sites. As one of six cooperative test sites in the Western Canadian Potato Breeding Program, the potato agronomy research program at CDCS conducts Advanced Adaptation Level 1 and 2 trials, Prairie Early Replicated Trial (80 and 95 day harvests), Prairie Maincrop Replicated Trial, the North Central Trial and a Spacing Trial. Performance of test lines in these trials is evaluated by the breeder, test site cooperators and industry staff.

Research Projects

Prairie potato regional trials

Approximately 100 lines were grown in the four replicated regional trials at CDCS. Data were collected on 30 to 40 agronomic and quality factors including yield, maturity, specific gravity, culinary and processing quality. Another 30 lines were grown as part of a North Central Trial comparing breeding material from Alberta with that of programs located in the north central USA. Data from the Regional Trials and from the North Central Trial were sent to Dr. Dermot Lynch at the AAFC—Lethbridge for analysis and summarization for the Prairie Potato Breeding and Selection Committee.

Effects of in-row spacing on yield and quality of potato selections

Twelve cultivars and advanced lines from the regional trials were planted at three in-row spacings in four replicates in a randomized complete block design. The cultivars/ lines planted were Atlantic, Russet Burbank, Shepody, AC Stampede Russet, AC Peregrine Red, V0404-4, V0391-4, V0887-4, V0299-4, FV9649-6, CV92056-4, and CV88014-11. The in-row spacings were 9, 12 and 15 inches. Yield, size distribution and quality data were measured.

Fresh market variety trial

A demonstration trial was planted to compare fresh market cultivars. Forty-six varieties including red-skinned, white-skinned, russet, yellow-fleshed and novelty potatoes were showcased for Alberta's market garden producers. Some new varieties show promise as fresh market cultivars and some varieties are particularly well suited to small potato production.

Rhizoctonia control trial

Several biocontrol and chemical seed piece treatments were used to control stem canker and black scurf on fresh market potatoes inoculated with *Rhizoctonia solani*. A greenhouse study was conducted during the winter months using Maxim PSP, Blocker, Quadris in-furrow, T22PB, CDCS-30, Companion, two rates of 94815 and Intercept treatments on Yukon Gold potatoes. Treatments in the field component of the study included Maxim PSP, Quadris in-furrow, Blocker, Senator, EN0516, Companion, CDCS-30, and three rates of 94815. Four replicates of Yukon Gold, Penta, Norland and Russet Burbank varieties were used in the field component of the study. Preliminary results from the field trial were presented at the PGA annual meeting and further analysis is currently underway. A second year of this trial is planned for 2002.

Russet Burbank vine management

Eight vine kill strategies were studied in two commercial fields of Russet Burbank potatoes near Cranford, AB to determine how much tuber bulking occurs during vine kill and how various methods of vine kill affect tuber quality. Yield data, size distribution, specific gravity, stem-end discoloration and fry quality were assessed. This was the first year of a two to three year study. Tuber bulking was occurring in one field (green vines), while the other field showed signs of senescence and very little bulking. In the green field, the best yield was obtained when vines were not killed (green harvest) or were sprayed with Reglone one week before harvest. In the senescent field, rolling vines then spraying with Reglone two weeks before harvest gave the best yields. Rolling alone reduced yield in both fields of Russet Burbank, possibly due to renewed vegetative growth. Liberty was as effective as Reglone for killing vines under the hot, dry conditions experienced during harvest in 2001.

Retention of red skin color during storage

This preliminary study was set up to compare red-skinned potato varieties and to determine the effects of storage temperature, environmental growing conditions, and variety on skin color retention. Thirteen red-skinned cultivars (AC Peregrine Red, Asterix, Cal Red, Cherry Red, Chieftan, Nordona, Norland, Red Cloud, Red Pontiac, Red Ruby, Rode Eersteling, Ruby Gold, Sangre and Viking) were grown at CDCS, harvested and stored at 6, 8 and 10°C. Skin color was assessed soon after harvest and will be assessed again after several months. Norland potatoes grown in Manitoba, Saskatchewan and Alberta have also been stored at 6, 8 and 10°C to determine the effect of environmental growing conditions on skin color retention.

Control of potato specific gravity using potassium

Three rates of potassium chloride were applied prior to planting Russet Burbank potatoes. The preliminary trial was located at the Lethbridge Correctional Centre. Petiole testing was conducted throughout the growing season and yield and quality data were collected at harvest. Drought conditions, irrigation restrictions and extreme heat during the growing season contributed to a poor quality crop. Although higher potassium chloride rates resulted in a suppression of specific gravity, results were not significant due to poor overall yield and quality.

Phosphorus and compost on potatoes

See Soil and Water Agronomy Program section for a description of this collaborative project.

Technology Transfer Services

Information was provided by the program leader, M. Konschuh, to producers, processors, and other industry staff as requested. Information on such topics as GMO testing, cultivar evaluations and research project results was presented at industry meetings and through direct contact. Several field days were hosted by CDCS to provide producers and industry staff with information on disease management and new potato cultivars.

The majority of the extension responsibilities for the potato program at CDCS are handled by the potato extension agronomists, Clive Schaupmeyer and Lori Delanoy (see section on Potato Agronomy and Extension Program). The program leader for the vegetable crops program (Brooks), Paul Ragan, also fields many of the extension calls from fresh market potato producers.

Potato Agronomy and Extension Program

L. Delanoy and C. Schaupmeyer

The objectives of the potato agronomy and extension program are to provide sound agronomic advice and assist the growers in improving quality and maximizing yields. This is done for Alberta's potato industry through direct contact, newsletters, factsheets, and presentations at conferences and workshops.

Technology Transfer Services

On-farm demonstration

The extension agronomists, in association with the Potato Growers of Alberta, organized three on-farm demonstration projects.

Potassium thiosulfate was foliar applied to both Shepody and Russet Burbank. Yield data showed no significant differences between treatments. This trial will be repeated in 2002.

Quadris (azoxystrobin) was foliar applied to Russet Burbank to prevent early blight and early dying resulting from early blight. Yields were calculated for both control and treated areas.

Three separate rates of potassium chloride were replicated in fields of Russet Burbank, Snowden and Niska. Yield data showed no significant differences between treatments within respective varieties. This trial will be repeated in 2002.

Industry field extension

The extension agronomists assisted growers with pre-plant water conservation, seed cutting, planting, irrigation management, integrated pest management and field diagnostics. Because of early frosts in both 1999 and 2000, the extension agronomists also assisted the growers in a timely harvest free of frost.

Workshops, field days and grower meetings

The extension agronomists, in association with the Potato Growers of Alberta, held six breakfast meetings beginning in early spring through to the end of harvest. These meetings covered a variety of topics ranging from irrigation management, IPM, early and late blight management, to any general or specific concerns. Potato growers continue to practice an aggressive late blight program and again, no late blight was found in southern Alberta.

The extension agronomists, with the help of several AAFRD and industry staff, put together a bacterial ring rot workshop to educate commercial field inspectors on the disease.

Agricultural Pest Act Management

In 2000, bacterial ring rot was found on a few farms in southern Alberta. As a result, AAFRD, PGA, processors and industry joined forces to assist growers with cleanup and containment. A bacterial ring rot action plan was developed for the 2001 growing season and fields were inspected twice in the month of August. Only trace levels of the disease were found, indicating a successful control program.

Seed Potato Program

P. Duplessis and T. Lewis

The main objective of the seed potato program at CDCN is to provide support to seed potato growers throughout Alberta. This is accomplished through research trials and extension services. The program works closely with the Potato Growers of Alberta to ensure that the needs of the industry are being met.

Seed Potato Repository. The purpose of AAFRD's seed potato repository is to maintain a collection of disease-free cultivars and lines to ensure that all participants in the Alberta seed potato industry have equal access to plants for nuclear production. This is accomplished by multiplying disease-tested stock plants for private labs. In 2001, 29 public potato cultivars and accessions and 23 private cultivars were distributed to private laboratories across the Western Provinces for multiplication. Plant Breeders' Rights issues are changing the face of high generation seed potato production in North America. Program staff continue to work closely with private breeders and their agents and Alberta Seed Potato Inc. to ensure that new varieties remain eligible for protected status while seed growers are increasing available seed stocks. Each year more private cultivars are added to the repository and their acreage in Alberta continues to increase.

Potato Spindle Tuber Viroid (PSTV) Mapping. In 2001, results from the 1999 and 2000 potato spindle tuber viroid survey were mapped in cooperation with other AAFRD staff using GPS software and submitted to the Canadian Food Inspection Agency. The maps were included in Canada's latest submission to the European Union. It is hoped that Alberta will have EU zone status when discussions are complete and be eligible to ship seed to the EU and EU zones in Eastern Canada. The survey results have proven Alberta is PSTV free and CFIA is publishing a paper on the results.

Research Projects

Inoculated plant trial in cooperation with Nova Scotia Agricultural College (NSAC)

In 2000, preliminary work was carried out on the performance of tissue culture potato plantlets inoculated with *Pseudomonas* spp. strain PsJN. Work done at NSAC has shown that infected plants grow faster in an aseptic environment and produce more tubers when placed in the greenhouse. Tubers produced in the greenhouse in 2000 were planted in the field in 2001. Results have yet to be analysed but preliminary results indicate no effect.

Red Norland trial

The repository at CDCN contains several Norland lines and growers are continually asking which is the 'best'. In 2001, the second year of a replicated field trial to evaluate the lines in a side by side comparison was completed. IdaRose and CalRed were also included in the trial. Harvest yield and size data were collected and tubers were ranked according to tuber type, color, splotching and overall appearance. Tubers will be re-evaluated throughout the storage season for color retention. The trial will be repeated in 2002 and will include the Norland Wisconsin line. In 2001, an early harvest component

was added to the trial to determine if any of the lines were better suited to early harvest conditions. Slides are available for interested growers to view and results will be presented following the completion of the 2002 field trial.

IdaRose vine-killing trial

In 2000, IdaRose tubers grown at CDCN had very poor skin set and did poorly in the trials. Research from other areas indicates the variety has potential as a long term storage red. In 2001, different methods of vine-killing were tested in an attempt to improve skin set. Skin set was better overall in 2001 than in 2002 but data analysis has not been completed. The trial will be repeated in 2002 if 2001 results are favorable and funding is available.

Gibberellic acid and spacing of Shepody and Russet Burbank

Gibberellic acid was shown to increase stem number and decrease average tuber size without reducing yield in trials conducted in 1998 and 1999 at CDCN. In 2001, Shepody and Russet Burbank tubers were planted at 8 and 12 inch spacings with either no treatment or 10 ppm GA3 to determine effect. The trial was irrigated to maximize yield potential. Final data analysis has not been completed at this time. To date there is no registered source of GA available for use on potatoes in Canada but a URMULE application has been re-submitted and we are optimistic we will soon have a registered product.

Red skin color trial

The objective of this study was to determine the color retention of several red varieties in the CDCN seed potato repository and to investigate the effect of a foliar 2,4-D application on skin color. Residue analysis of 2,4-D treatments has not been completed at this time. Data is still under review and skin color needs to be evaluated again. The trial will be modified in 2002 based on residue analysis and finalized 2001 results.

Variety demonstration trial

Potato varieties and selections maintained in the repository are grown in the greenhouse annually to ensure that the lines have remained pure and productive. Nuclear tubers produced at this facility are planted in the field for assessment of 'trueness to type'. Evaluation of potato cultivars is necessary to ensure that the seed potato industry is being provided with a high quality seed source. This past year, the plot included 90 cultivars. Growers visited the plot during the regional trial tour and took the opportunity to look at the many cultivars that are in the repository. Visitors from Mexico were interested in the trial as were representatives from private companies looking at niche market varieties. This year the trial was also used to evaluate blossom color of different potato varieties and pictures were taken as the first step in the development of a variety information database.

Prairie regional trials — early and main crop replicated trials

These trials are conducted annually in cooperation with AAFC-Lethbridge. They are an integral part of the AAFC Potato Breeding Program. New cultivars and accessions are compared with well-known standards to assess performance, maturity, yield, specific gravity, and culinary and processing quality. The observations are used to select new potato cultivars for the prairies.

CDCN was an early and a main crop trial site in 2001 and was also an irrigated demonstration trial site for 10 advanced selections and six industry standards. The early crop trial included nine breeding lines and Atlantic, Norland and AC Ptarmigan as standards. The main crop trial included 22 breeding selections and two Colorado Norkotah Russet strains for evaluation. Russet Burbank, Ranger Russet (Amisk), Russet Norkotah, Shepody, Atlantic, Norvalley, Norland, Sangre and Snowden served as standards. Growers had the opportunity to tour the site on August 16 in conjunction with a PGA grower meeting and Dr. Dermot Lynch of AAFC was on hand to answer questions about the advanced selections.

Technology Transfer Services

The seed potato specialist organized the CDCN potato field day and grower tour and participated in meetings and conferences. These included: area meetings of the PGA, Washington State Potato Conference and Trade Show, Moses Lake, WA; Potato Association of America Annual Meeting, St. Augustine, FL; Atlantic Tissue Culture Conference and Biotechnology Association Workshop, Fredericton, NB and the PGA Annual Meeting, Banff, AB.

The seed potato specialist provided extension services to growers and industry personnel through direct contact and presentations at meetings and conferences. She also acted as a liaison with the Canadian Food Inspection Agency.

In 2001, genetically modified organisms in potatoes exported to Japan became a critical issue for Alberta producers and processors. The seed potato specialist focussed many efforts into keeping AAFRD and industry informed of recent happenings and organizing seed lot trace backs and seed lot testing for spring 2002.

The seed potato specialist and technologist worked closely with new and interested lab, greenhouse and seed producers to help ensure that producers had adequate information and resources.

Vegetable Crops Program (Brooks)

P. Ragan, S. Jangula and H. Sagert

Applied field research and extension activities are designed to serve market gardeners, large-scale fresh vegetable growers, and contract processing growers. Variety adaptation and earliness enhancement of crops through improvements in cultural management practices are the main research activities of the vegetable program. Technology transfer is carried out through on-farm visits, publications and participation in commodity organization conferences and workshops.

Research Projects

Variety adaptation

Approximately 300 varieties of 10 types of vegetables were evaluated. In addition, succession plantings of transplant cauliflower and sweet corn varieties were evaluated along with plant density treatments in carrots and cooking onions. Storage quality observations on all cabbage and onion varieties continued up to six months after harvesting.

Detailed results of varieties tested were reported in CDCS Pamphlet 2002-5 *Vegetable Variety Adaptation Trials 2001*. Copies were supplied to 30 participating seed companies. Workshops were held across the province in November to discuss findings and make recommendations to producers. These workshops also provided opportunities for producers to suggest priority areas for future research.

Production management trials

Detailed results of production management trials, along with summaries were reported in the CDCS Pamphlet 2002-4 *Vegetable Production Trials 2001*. A brief description of these trials follows.

Winter Squash and Pumpkin Irrigation Management

Twelve varieties of winter squash and pumpkins were planted in a four replicate split plot trial using irrigation treatment as the main plot. Irrigation water was applied weekly from planting until bloom at a full inch, two-thirds and one-third inch treatment rate. After bloom, irrigation water was applied weekly in only the full and two-thirds inch treatments until late August, after which no further irrigation was applied.

Harvest showed that yield was significantly affected by irrigation, being reduced as the amount of water which was applied was reduced. Yield reductions were the result of

lower per plant yields of fruit that were generally of higher maturity. Irrigation treatment also significantly affected fruit shapes. Less water applied caused fruit to become shorter but wider in girth. Large fruited varieties were most affected which is a distinct market advantage.

Celery Gibberellin Timing

Eleven varieties were treated to 50 ppm gibberellin 30 and 50 days after planting in a three replicate RCB trial. Stalk length in both treatments increased over the check treatment, significantly at the 50-day interval only. At the 30-day interval, the gibberellin effect was exhausted allowing the check treatment to catch up. The trial showed no varietal differences, however, gibberellin applications more than 30 days before harvest were of no market advantage.

Cooking Onion Population

Thirty-five onion varieties were direct seeded in a three replicate RCB trial and hand thinned to population treatments of six and 12 plants per foot of row. Harvested bulbs were graded and indicated that at the six plants per foot treatment, select varieties produced a significantly higher yield of jumbo grade bulbs. Higher in-row spacings do have the potential of increasing jumbo bulb yield in Alberta, however, variety selection is critical.

Carrot Plant Density

Sixty-three varieties grown at plant density treatments of 390,000; 520,000; 990,000 and 1.2 million plants per acre in a non-replicated trial showed that carrot root size is highly influenced by plant density. As mean root diameter falls, plant density increases, this knowledge can be used to manipulate market requirements whether for fresh market or processing. Each variety responds differently to plant population treatments and therefore variety selection by producers becomes very critical in determining market requirements of a carrot crop.

Nitrogen and phosphorus rate influence on garlic production

This trial investigated the effects of fall broadcast application of nitrogen and phosphorus on the yield and bulb size of garlic. A three replicate randomized complete block trial was planted with the following treatments:

Variety: Music and Vernon, hard-necked continental types.

Fertilizer: nitrogen and phosphorus per acre interaction treatments of 100 x 200, 200 x 400, 300 x 200, 100 x 400.

Overwintering: straw mulch vs. no mulch

The non-mulched treatment failed to overwinter and consequently the trial was discarded. The fact that straw mulch is required to overwinter garlic in southern Alberta was confirmed.

Technology Transfer Services

A one-to-one, on-farm extension service was provided to producers in the southern region of the province. Specialized equipment was loaned to producers to encourage adoption of new technology. Popular items included: two precision drills, transplanters and plasticulture equipment. Program staff also provided a seed belt punching and calibration service for producers using Stanhay seeders. Seed lots are matched with the best combination of belt hole size and number of holes to ensure optimum plant density in the field.

Annual workshops for vegetable producers were given to provide variety recommendations and guidelines to data interpretation as reported in the CDCS Pamphlets 2002-4 and 2002-5. These workshops provided an opportunity for producers to comment on the direction of research programs. A field day also provided producers the opportunity to view field trials in progress and to learn about new production techniques.

The *Processing Vegetable Growers Newsletter* was edited and posted quarterly.

New Crop Development Unit

Dr. Stan Blade, Unit Leader

The mission of the New Crop Development Unit (NCDU) is to ensure that applied research, industry development and technology transfer activities are appropriately channelled to support the special crop industries in Alberta. This is consistent with the market-driven thrust of Alberta Agriculture, Food & Rural Development (AAFRD) programs and also fosters sustainable agricultural production. NCDU clients include primary producers, commodity organizations, agribusiness, food processing companies, Agriculture and Agri-Food Canada personnel, university scientists and other specialists, both within and out-of-province. The NCDU exists to promote and support crop diversification and value-added initiatives in Alberta.

The New Crop Development Unit is one of five work units within the Plant Industry Division (PID) of Alberta Agriculture, Food and Rural Development.

Special crops are defined as alternative or non-traditional crops that generally are grown on small acreages, often under contract, and usually outside the control of the Canadian Wheat Board. This definition is not bound by acreage, and it is recognized that crops designated as "special crops" will change over time. Some examples of special crops currently being grown on a commercial scale in Alberta include buckwheat, canary seed, caraway, chickpeas, coriander, corn, dill, dry bean, faba bean, field pea, chickpea, low-THC hemp, ginseng, lentil, medicinal plants, mustard, peppermint, safflower, spearmint, sugarbeet, sunflower, wild rice, and miscellaneous herbs and spices. NCDU programs encompass all of these crops, with emphasis on those of greatest economic importance.

Most special crops are produced under contract or for direct marketing, and much of Alberta's production is exported. There is considerable value-added processing of crops such as mustard, sugar beet and herbs and spices. Others, such as sunflower, lend themselves to consumer marketing. The value of processed special crops in Alberta has not been established.

The NCDU receives strategic direction directly from the crop and processing industries it serves, as well as from commodity organizations, e.g. the Alberta Pulse Growers Commission and the Alberta Special Crop, Horticulture and Forage Product Teams. All programs in the Unit are reviewed every three years by scientific colleagues and industry representatives, including producers, processors and agribusinesses.

The following programs currently comprise the NCDU: administration, plant pathology, post-harvest technology, soil and water agronomy, special crops, and weed science. All of these programs are represented at CDCS. In addition, there are NCDU staff at CDCN (special crops, farm team, administration and apiculture) in Edmonton, Fahler (apiculture) and the Beaverlodge Research Farm (special crops).

Apiculture Program

K. Tuckey and D. Colter

The Apiculture Section of AAFRD provides extension and regulatory service to the beekeeping industry of Alberta. Offices are maintained in Edmonton and Falher.

The extensive drought throughout Alberta reduced the average per colony honey production to 50 per cent. By year-end the price of raw bulk honey had increased to $1.10 per pound—a four-year high. Most commercial beekeepers benefited from the drought assistance offered under the Farm Income Assistance Program (FIAP) and many used the Honey Crop Insurance offered through Alberta Financial Services Corporations. Fifteen per cent of Alberta's honey bees were devoted to the production of hybrid canola seed in southern Alberta. Parasitic mites continue to spread their influence across the province and a new, resistant strain of American Foulbrood is causing concern.

Alberta beekeepers operate about 30 per cent of the honey bee colonies in Canada and normally produce close to 40 per cent of all of Canada's honey. Most of Alberta's honey is exported from the province which helps to increase the province's income from agricultural products. The beekeepers of Alberta provide summer employment for many Alberta students and their bees provide unpaid pollination services to many crops, especially to canola.

Provincial Apiculturist Kenn Tuckey will be retiring in February of 2002. Since he joined the department in 1990 the number of beekeepers in the province has decreased by 12 per cent but the number of colonies in the province has increased by 50 per cent. The increase was originally spurred by the need to provide colonies of honey bees for the production of hybrid canola seed in southern Alberta but recent growth has resulted from reasonable returns from the honey produced and the desire of the beekeepers to benefit from efficiencies of scale.

In these eleven years the beekeepers of Alberta have perfected systems for wintering their honey bees and have learned how to cope with the parasitic mites varroa and honey bee tracheal mites. Now they are faced with varroa mites that are resistant to a registered acaricide and with American Foulbrood that is resistant to the only registered antibiotic.

Apiculture registrations 2000

The Alberta Bee Act requires people who own and possess honey bees or beekeeping equipment in Alberta to register, annually, the number of colonies they own and the municipalities in which their bees are located (Tables 1, 2 and 3).

The large number of beekeepers shown in Regions 2 and 4 reflects, in part, the number of hobby beekeepers living in Calgary and Edmonton. The relatively large number of colonies in Region 1 reflects the honey bee colonies needed to service the hybrid canola seed production industry in that area.

Table 1. Number of beekeepers and colonies.

Region*	2000		2001***	
	Beekeepers	Colonies	Beekeepers	Colonies
N R**	6	4,616	6	3,883
1 Southern	81	54,803	86	56,542
2 North Central	162	16,800	155	17,333
3 North East	106	30,890	104	31,164
4 North West	278	58,851	265	62,198
5 Peace	114	51,241	109	55,360
Total	747	217,201	725	226,480

* region as established by AAFRD

** non-resident beekeepers who operate colonies in Alberta

*** as of December 31, 2001

Table 2. Number of beekeepers — by region and size of operation.

Colonies operated	Number of beekeepers per region* 2000***						
	NR**	1	2	3	4	5	Total
0	1	14	38	19	53	11	136
1-50	1	48	91	55	140	30	365
51-600	1	12	20	14	47	38	132
601+	3	12	6	16	25	30	92
Total	6	86	155	104	265	109	725

* region as established by AAFRD
** non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 2001

Table 3. Bee colonies operated — by region and size of operation.

Size of operation	Number of colonies per region* 2001***						
	NR**	1	2	3	4	5	Total
1-50	14	567	906	765	1,436	352	4,040
51-100	-	285	777	200	1,341	442	3,045
101-200	137	432	221	437	1,626	1,399	4,252
201-600	-	2,405	2,633	3,847	8,070	8,143	25,098
601-1250	732	1,108	646	7,956	11,390	19,494	41,326
1251-2000	3,000	2,860	3,350	3,840	7,408	1,700	22,158
>2000	-	48,885	8,800	14,119	30,927	23,830	126,561
Total	3,883	56,542	17,333	31,164	62,198	55,360	226,480

* region as established by AAFRD
** non-resident beekeepers who operate colonies in Alberta
*** as of December 31, 2000

Data from the beekeeper registration forms show that Alberta beekeepers placed those 226,000 colonies in 7,173 beeyards or apiaries. Most of these beeyards are on land owned by someone other than the beekeepers and in most cases the landowners receive a "rent" of about 30 pounds of honey for the inconvenience of having bees on their property.

Economics of beekeeping

About one-third of Alberta's honey crop is sold cooperatively but all honey is sold on an open market. During 2001 the price of raw bulk honey rose from about $0.85/pound to approximately $1.10. This price increase was prompted more by USA trade actions against honey from Argentina and China than by the laws of supply and demand. By year end the US International Trade Commission had determined that honey imported from these two countries had harmed American beekeepers. The question of further tariffs against honey from these two countries is still not settled.

The United States is an important honey market for Alberta beekeepers so any restrictions on honey from China and Argentina creates opportunities for Canadian honey. There are reports that now that actions against China and Argentina have been successful, the US honey industry may try similar actions against honey from Canada and Mexico. The European concern over genetically modified organisms (GMOs) has a

negative effect on the sale of Alberta honey since much of it comes from hybrid canola plants some of which are GMO. There is a reluctance to purchase Alberta honey. This is reflected in the price received or the volume of honey being shipped. Honey gets caught in the controversy even though modern processing systems routinely filter all protein (the pollen component) from the honey.

Demands of the hybrid canola seed production industry in southern Alberta continue to exercise a major influence on Alberta beekeeping. In 2001 at least 34,000 colonies were devoted to hybrid canola seed production. This is a considerable reduction from the 1999 high of 55,000 colonies. Requirements for the 2002 season have not yet been established. Fluctuations in pollination requirements as the fortunes of the canola industry vary from year to year, but the long-term projections are for a large increase in the number of colonies needed in this project. This demand for honey bee colonies is reflected in the tables above which shows a small number of beekeepers and a very large number of colonies in Region 1. As demand for honey bees increased, beekeepers from further afield were being attracted to this venture. It is known that the per colony honey crop from these colonies will be very small—about 20 per cent of the provincial average crop from those colonies operated only for honey production. The rental rate for these colonies stays competitive with the normal returns from honey production.

Alberta honey production 2001

The year 2001 was unusual in the fact that not one area of the province experienced a good honey crop. Widespread drought adversely affected the spring build up of colonies and the flow of the nectar required to produce honey. Only the occasional beekeeper reported a good crop. In some areas beekeepers were faced with the doubled problem of mites and grasshoppers—the hoppers ate those flowers that did grow.

As mentioned earlier the bees on canola pollination produce little honey. The number of colonies per acre of canola is high in order to ensure complete pollination. The stocking rate of two or three colonies per acre is too high to allow for a good honey crop. It appears that the 2001 Alberta average honey crop will be about 71 pounds per colony (for all colonies)—50 per cent of the long term average—for a total crop of 16,000,000 pounds.

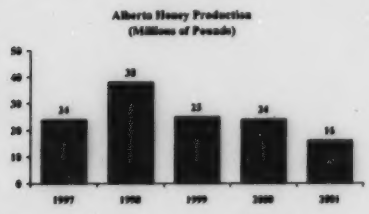

Figure 1. Alberta Honey Production (Millions of pounds)

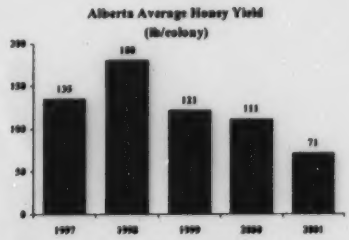

Figure 2. Alberta Average Honey Yield (lb/colony)

Apiculture inspections and surveys

As varroa mites (*Varroa destructor* an ectoparasite of honey bees) are found in more beekeeping operations, beekeepers are becoming more aware of the need to test and treat their own bees for the presence of parasitic mites. The original Alberta varroa mite findings (1993 and 1994) were in operations that received honey bees directly from British Columbia. Since 1995 varroa mites have been well established in the permanent bee population. By the end of 2000, varroa mites have been identified through most of the province except the St. Paul area but during 2001 varroa mites were found in operations along the western side of this "clean" area.

Honey Bee Tracheal Mites (*Acarapis woodi*) have a distribution very similar to the varroa except that they are now found on the eastern side of the "clean" St. Paul area.

Early in 2000 laboratory results showed that American Foulbrood (AFB) (a bacterial disease of immature honey bees) that is resistant to oxytetracycline hydrochloride (OTC) exists in Alberta. OTC is the only labeled preventative drug for the control of AFB. This new strain has been labeled rAFB.

During 2001 two surveys were carried out to determine the extent of rAFB in Alberta. Beekeepers were asked to examine the hives that died over the winter and to mail samples of any AFB found for laboratory analysis. A survey of live hives was conducted to search for any signs of AFB and again samples were submitted to a laboratory. The live survey was designed to look at only five hives in only some beeyards a beekeeper owned. Consequently, progress was slow with much time used for driving. Thirty-one colonies of the 1,286 inspected were AFB positive.

By the end of the season rAFB had been found in 40 beekeeping operations with a total of 69,000 colonies. In most cases the infestation levels were very low and the beekeepers were doing a good job of controlling the problem. In a few cases beekeepers, who, in 2000, had discovered a significant problem with rAFB, took major steps to control the rAFB by melting down brood combs and by using electron beam irradiation on much of their equipment. These steps seem to have been very successful. Except as noted below, the only control available for rAFB is irradiation or destruction of comb.

In the fall of 2001, through the combined efforts of the Alberta Beekeepers Association, AAFC, AAFRD and the Alberta Veterinary Medical Association, Alberta beekeepers whose operations had been shown to be rAFB positive were able to get a prescription to medicate their bees with Tylosin. The success of this initiative should be apparent in the spring of 2002.

Interprovincial movement of honey bees

A permit is required from AAFRD to move Canadian honey bees into Alberta. Regulations also require that all bees coming into Alberta from provinces known to have varroa mites must be treated for the control of the mite before entry. Several shipments were checked to confirm compliance with this regulation.

During the spring of 2001 permits were issued for the importation of 11,000 colony units (packages, nucleus or full size colonies) into Alberta from British Columbia. Most of these units were Alberta bees that were taken to BC in the fall of 2000 to winter in southern BC.

Overwintering honey bees

Alberta beekeepers continue to winter their honey bees in British Columbia, in ventilation controlled buildings or outdoors. Bees are wintered in a number of formats. The most common method is as two brood chamber colonies outdoors but a few beekeepers utilize three-super colonies to winter outside. Bees wintered indoors or in British Columbia may be one or two brood chamber colonies or nucleus colonies (nucs) with only five or six frames. Table 4 provides wintering statistics for recent years.

Table 4. Winter survival of honey bee colonies.

Year	Colonies operated *	Units into winter		% Survival
1996-1997	164,000	In	64,000	82
		Out	102,000	80
1997-1998	174,000	In	55,000	87
		Out	117,000	89
1998-1999	205,000	In	64,000	83
		Out	133,000	83
1999-2000	211,637	In	63,425	80
		Out	146,133	82
2000-2001	217,201	In	59,338	81
		Out	161,682	81
2001-2002	227,000#		23,000#	n/a

* indicates the number of colonies operated prior to the winter
# estimate

Government Programs

Agriculture Financial Services Corporation—Insurance Division

This joint Federal, Provincial and industry program Honey Crop Insurance continued to protect 56 Alberta beekeepers operating 72,000 colonies from losses due to poor honey yields compared to their long-term average yield. Thirty-four beekeepers made claims totaling $1,300,000 against the program. These numbers are all larger than in 2000. Several beekeepers arranged for coverage for the first time when the drought could apparently continue through the season and affect their crops.

Farm Income Assistance Program (FIAP)

The provincial government initiated this program in the spring of 2001 in recognition of the extra expenses Alberta farmers were experiencing because of the widespread drought. Registered beekeepers with 20 or more colonies were eligible for a payment of $4.00 per colony. This program injected close to $900,000 into the Alberta beekeeping industry.

Net Income Stabilization Account (NISA)

This joint Federal, Provincial and industry program, which assists farmers to provide long term monetary security for their farms, was first offered to beekeepers in the 1992 taxation year. Since then the program has been very popular with beekeepers and 136 beekeepers made contributions on $11,540,675 of net honey sales for the 2000 year.

Statistics

Each year the Production Economics and Statistics Branch of AAFRD does a survey of beekeepers to determine the crop received and other data about the Alberta beekeeping industry. This information is forwarded to Statistics Canada and included in country-wide figures. As well the same section periodically collects data on the economics of the beekeeping industry—both for honey production and for pollination. These are published as Agdex # 821-62. The latest compilation was for the 2000 crop.

The Canada—Alberta Farm Business Management Initiative

A profile was published on the "Commercial Honey Industry" in their AgVentures Series, Agdex # 616/830-1 during 1998. It was updated in 2001 and serves as a valuable resource for persons wanting to get into or expand commercial beekeeping.

Farming For The Future and On Farm Demonstration Program

These provincially funded programs assist in basic and applied research and in proving the worth of new ideas on the farm. From time to time beekeeper related subjects are tested.

Technology Transfer Services

Both apiculturists provide monthly articles to the *Alberta Bee News*, published by the Alberta Beekeepers' Association. Presentations were given to the annual meeting of the Alberta Beekeepers' Association and to local beekeepers meetings upon request.

Beekeepers and potential beekeepers consult the apiculturists on a regular basis requesting information or service. Email is becoming a very important communication device to beekeepers. Forty per cent of the beekeepers have provided email addresses. Email is routinely used to provide timely information to a large segment of the Alberta bee industry.

Interpreting the beekeeping industry to other segments of the government, and to industry, is an important facet of the duties of this section.

A large part of any summer office time is used providing advice to members of the public who have called with "honey bee" problems. At least half the time the insects involved are bumble bees or some type of wasp and some time is used to provide suggestions for solutions.

Plant Pathology Program

K.F. Chang, R.J. Howard, M.A. Briant, D.A. Burke and Y. Yang

The plant pathology program has a mandate to conduct applied research on important diseases of horticultural, forage and specialty crops. This research encompasses field, laboratory, growth chamber and greenhouse experiments, as well as disease surveys. Findings from this work and from the research of other cooperative scientists are presented to commercial producers through technology transfer programs. The plant pathology program also provides service in the form of support to crop production research programs at CDCS. Some plant pathology projects are also discussed in the report of the post-harvest technology program.

Research Projects

Diseases of pulse crops

Disease survey of field pea

Nine pea fields in the Strathmore area were surveyed and assessed for incidence and severity of root rot. More than 200 plants were taken from each field and assessed for disease levels. Overall disease incidence was low, ranging from 1.6 to 27.3 per cent and averaging 9.4 per cent. In most cases, disease severity was also quite low and only minor infection occurred in the roots. However, at a single location in one of the fields, incidence was 78.6 per cent and severity was 4.0. *Rhizoctonia solani* and *Fusarium* spp. were isolated from diseased root tissues and confirmed as the causal pathogens.

Disease survey of chickpea in southern Alberta

Forty-eight commercial chickpea fields were surveyed during the third week of July for root rot and ascochyta blight. Very slight root rot and ascochyta infection occurred in 41 of the fields. Hot, dry weather restricted disease development in 2001. The most frequently isolated microorganisms from infected roots were *Fusarium* spp. (60%), followed by *Penicillium* spp. (41%), *Alternaria* spp. (28%), *Fusarium roseum* (16%), *Rhizoctonia solani* (12%), bacteria (6%), *Pythium* spp. (2.5%), *Aspergillus* spp. (1.3%), and *Epicoccum* sp. (1%). Occasionally, *Trichoderma* sp. and *Sclerotinia sclerotiorum* were also isolated. A preliminary greenhouse study revealed that *F. oxysporum* and *F. solani* were pathogenic to kabuli chickpea.

Evaluation of fungicidal drench to control rhizoctonia root rot of chickpea

Eight fungicides were tested for their efficacy to control root rot on Kabuli chickpea cv. B90 in a greenhouse study. Fungicides used were Terraclor (1500x; commercial product diluted with water by the ratio of 1g/1.5 L), Ronalin and Rovral (each at 1000x), Botran, Benlate, Easout, Mertect, and Vitavax (each at 2000x). The control and Botran treatments had the greatest mortality, while plants drenched with Terraclor had significantly less mortality, followed by Rovral. All fungicide applications increased dry weight of chickpea compared to the control treatment.

Relationship of bean seed infection with anthracnose to disease development and seed microflora

Bean seeds, (cv. Navigator) naturally infected with anthracnose, were sorted according to severity of seed discoloration and sown into pots in a greenhouse study to determine correlation between infected surface area (ISA) on the seed and seedling emergence. Seedling emergence was negatively correlated with ISA. Seeds with more than 50 per cent ISA had the lowest emergence, and the emergence rate of seed with 20 per cent ISA was also significantly lower than that of clean seed. Microorganisms isolated from naturally infested Navigator seed included *Colletotrichum lindemuthianum*, *Fusarium* spp., *Alternaria* spp. and bacteria. The predominant species was *C. lindemuthianum*, which could even be isolated from apparently healthy seeds. Morphologically distinct isolates of this pathogen were observed.

Cultivar response to and chemical control of bean anthracnose under greenhouse conditions

Forty-seven bean cultivars were tested for resistance to four isolates of anthracnose. The navy bean cultivars Skipper, Fleetwood and Upland; pinto bean cultivars Topaz, Pinray, Earliray and Agassiz; kidney bean cultivars Sacramento and Montcalm; and Great northern bean CDC Nordic all showed high resistance to the pathogens. The other cultivars tested were either moderately resistant or highly susceptible to the pathogen. Seeds treated with the fungicides Benlate, DCT, Dithane, Easout, Maxim and Vitaflo showed significant inhibition of the pathogen on PDA plates. Vitaflo and Botran significantly increased the seedling emergence rate compared to the non-treated control. All seed treatments significantly reduced disease severity in the pot study. For preventative purposes, all fungicides tested significantly reduced anthracnose severity on Navigator seedlings in the pot study. A 12 per cent disease severity index was observed for non-treated seeds, while the disease severity index only reached 3 per cent for treated seed.

Zineb with Rovral reduced the severity index more than the application of Rovral alone. For therapeutic purposes, Botran, Bravo, Bravo plus Zineb, Maxim, Ronilan, Ronilan plus Zineb and Rovral effectively controlled the disease. Dithane, Benlate and Thiram controlled anthracnose to a lesser extent, but reduced disease severity compared to the control treatment.

In cooperation with Dr. S.F. Hwang, a field trial for the control of the disease in dry bean cv. Navigator was conducted at Vegreville, AB, in black chernozemic sandy loam soil. The foliar fungicide treatments Bravo (1000g ai/ha), Tilt (125g ai/ha), Dithane (1688g ai/ha) or Quadris (125 or 175g ai/ha) were applied on 1 August and/or 13 August using a knapsack sprayer. Anthracnose severity was rated on the basis of percent foliar infection on the upper, middle and lower portions of the plants. Disease severity was similar to the untreated control for all treatments on all three portions of the plants. For the upper portions, disease was significantly more severe for the plots treated with Bravo + Quadris than for plots treated with Dithane on August 1.

Evaluation of fungicidal seed treatments to control rhizoctonia root rot of dry bean, soybean and chickpea

Three trials were set up in the fields at CDCS in the spring of 2001 to control rhizoctonia root rot of dry bean (cv. US1140), soybean (cv. Gaillard) and chickpea (cv. Dwelley). Seed was treated with the experimental fungicides U2051, L1022 or with L0020 at 0.128 mL/kg seed, either alone or in combination with L1031 at 1.33 mL/kg, U2051 at 2.6 mL/kg or U2789 at 1.92 mL/kg seed. *Rhizoctonia*-inoculated and non-inoculated controls were seeded along with the treatments.

For dry bean root rot control, seedling emergence was significantly greater ($P \leq 0.05$) for all seed treatments tested compared to both the inoculated and noninoculated controls, except for the L0020 and the L0020 + U2789 treatments. Seed yield was similar among all fungicidal seed treatments in the trial and was significantly greater for the L0020 + U2051 seed treatment compared to the inoculated control.

For soybean root rot control, seedling emergence was significantly greater for all seed treatments tested compared to both the inoculated and noninoculated controls, except for L0020 alone and U2051 alone. Seedling emergence was significantly greater for L1022 alone than for these two and the L0020 + U2789 treatment. Seed yield was statistically similar among all fungicidal seed treatments in the trial and was significantly greater for L0020 + U2051 compared to the inoculated control.

For chickpea root rot control, emergence and seed yield were significantly higher than the inoculated control for all of the seed treatments in the study. All fungicide seed treatments also produced plant stands and seed yields that were significantly higher than for L0020 applied alone, but emergence for L1022 was significantly lower than for the other treatments in this group. There were no significant differences in emergence or yield between the inoculated and noninoculated controls.

Control of fusarium and pythium root rot of dry bean, rhizoctonia root rot of field pea with fungicidal seed treatments

Trials with the same treatments and experimental design were conducted in the fields at CDCS for controlling each of the diseases. Seeds of dry bean cvs. US 1140 and Thunder, and field pea cv. Swing were treated with Vitaflo 280 (88 g ai/100 kg seed) or Apron Maxx (6.25 or 12.5 g ai/100 kg seed) in a Hege II small batch seed treater. The plot was seeded in a randomized complete block design with four replications.

For the control of fusarium root rot, seedling emergence was significantly greater for all seed treatments compared to the inoculated control and was significantly greater for the Apron Maxx treatments than for the Vitaflo 280 treatment. Seed yield was similar among all fungicidal treatments in the trial, but was significantly greater than the inoculated control only for the Apron Maxx treatment at the lower rate.

For the pythium root rot control, seedling emergence was significantly greater for the Apron Maxx treatments compared to the inoculated control. Seed yield was similar among all treatments in the trial. Seedling emergence and seed yield were significantly greater for US 1140 than for Thunder.

For rhizoctonia root rot control, seedling emergence was significantly greater for both Apron Maxx treatments compared to the inoculated control. Yields were significantly greater for all fungicidal treatments in the trial relative to the inoculated control. Fungicide treatments did not significantly improve stand or yield relative to the noninoculated control.

Evaluation of fungicidal seed treatments for the control of rhizoctonia root rot of chickpea and lentil and fusarium root rot of lentil

Seed of chickpea cv. B-90 and lentil cv. Milestone was treated with Apron Maxx (6.25 or 12.5 g ai/100 kg seed), or with Crown (90.0 g ai/100 kg seed) and seeded into experimental plots at Brooks, Alberta to evaluate efficacy against rhizoctonia root rot. Milestone lentil treated with the two Apron Maxx treatments was also seeded to evaluate efficacy against fusarium root rot. Emergence and yield were similar among all seed treatments in the chickpea and lentil rhizoctonia trials and the noninoculated control and were higher for all seed treatments than for the inoculated control. For the lentil trial for efficacy against *Fusarium*, seedling emergence for both seed treatments was significantly greater than for the inoculated control, but significantly less than the noninoculated control. Application of Apron Maxx at the higher rate resulted in greater stand establishment than at the lower rate. The two seed treatments produced yields of intermediate size that were not significantly different from either the inoculated or the noninoculated control. However, there was a general upward trend in seed yield with the heavier application of Apron Maxx.

Evaluation of fungicidal seed treatments to control seedling blight of chickpea caused by botrytis

Naturally-infested seed (10-20 per cent of seedlot) of chickpea cv. Myles was treated with Allegiance (0.16 mL/kg seed) alone as a control or in combination with Vitaflo 280 (3.3 mL/kg seed) or Crown (3.0 and 6.0 mL/kg seed). Emergence was similar for all treatments, but seed yield was significantly higher where Crown was applied at 6.0 g a.i./kg seed with Allegiance than where Allegiance was applied alone.

Efficacy of foliar fungicide formulations against ascochyta blight of chickpea

Experimental plots were established at two sites near CDCS to compare foliar treatments for control of ascochyta blight on chickpea. At both sites, chickpea cv. Sanford was seeded in a randomized complete block design with four replications. Healthy seed was sown at site A (Lendrum farm); naturally infected seed with a low germination rate was sown at site B (MacLeod farm). Fungicides used in the trial included Bravo, Quadris and Tilt with all combinations of sprays at different concentrations and application times. Yield was higher for site A than for site B, but disease levels were higher at site A. Where disease incidence was low, all fungicides reduced disease. Under more severe disease pressure, a single application of Bravo at

2600 g ai/ha, followed by two applications of Quadris, spaced two weeks apart, provided greater disease protection compared to a single application of Bravo or Quadris at the low rate, or to two applications of Bravo.

Cultivar screening of chickpea for resistance to *Rhizoctonia solani*

Seven chickpea cultivars, including kabuli and desi types, were sown in a replicated field trial to evaluate resistance to root rot caused by *R. solani*. Emergence was much lower where the pathogen was applied than in plots without inoculum. No highly resistant cultivars were identified, indicating seed treatment is essential for crop production.

Diseases of Herb Crops

Soil-drench treatments with *Trichoderma* and fungicides to control fusarium root rot of coneflower

Fusarium root rot (*Fusarium* sp.) is one of the most important seedling diseases of coneflower (*Echinacea* spp.) in Alberta nurseries. Effects of microbial antagonists (*Trichoderma* sp.) and fungicides (Dividend, Maxim-Apron-Dividend [MAD] and Maxim) on the management of this disease were investigated under greenhouse conditions. Twenty *Trichoderma* isolates demonstrated antagonistic activity to *Fusarium* in PDA plate bioassays, with inhibition rates ranging from 44 to 65 per cent. Some *Trichoderma* isolates significantly reduced disease incidence and severity in greenhouse experiments. An *in vitro* bioassay indicated that Dividend and MAD equally inhibited the growth of both *Fusarium* and *Trichoderma*, but, while Maxim strongly inhibited the growth of *Fusarium*, it had little effect on *Trichoderma*. Selected *Trichoderma* isolates were applied singly or in combination with Maxim in greenhouse evaluations. The results suggest that Maxim and *Trichoderma* could be integrated into a disease management program for fusarium root rot in coneflower.

Mint stolon rot/rhizome rot occurrence in 2001

Fifteen fields of Scotch spearmint and peppermint were sampled from Arrowwood, Bow Island and Carmangay throughout April and May of 2001 and subsequently rated for disease incidence and severity. At Bow Island, more young mint shoots emerged from lower areas than from hilltops where the soil was drier. Stolon rot was more common in the older fields (>4 years old) than in the one-year-old fields. At Arrowwood, where the mint crops were more than four years old, many of the rhizomes/stolons had rotted and disintegrated, so that fewer samples were collected. Presumably, crops in this condition are not profitable and should be replaced. In general, fields with the oldest stands and continuous cropping with mint had the highest disease incidence and severity. Further analysis of the ratio of organisms isolated per field compared to disease incidence and severity is necessary to obtain information about the cause of stolon rot.

Disease occurrence on *Echinacea angustifolia* in greenhouses and fields

Seedlings of *Echinacea angustifolia* (*Ea*) were visually examined for root rot diseases in three greenhouses. The disease incidence ranged from 0 to 45 per cent. *Fusarium* spp., *Rhizopus* spp., *Trichoderma* spp., *Alternaria* spp, and *Pythium* spp. were isolated from the roots. *Fusarium* spp. predominated. Nine fields of one-year-old *Ea* plants were surveyed. Aster yellows (AY) and root rot were the most commonly encountered diseases. Approximately 2 to 34 per cent seedlings were infected with AY and 4.2 to 81.8 per cent plants were winterkilled. Root rot may have been involved in the mortality in these cases, since the highest rates of AY infection were 24.3 and 34.1 per cent, but the highest rates of winterkill were 58.9 and 81.8 per cent and these did not occur in the same fields. Southern Alberta had very little snow cover during the winter of 2000-2001. This left the plots with little protection from strong winds and occasional cold outbreaks and may have contributed to high plant mortality.

Control sclerotinia root rot of coneflower under field conditions

Studies on the control of *Sclerotinia sclerotiorum* (*Ss*) on *Echinacea angustifolia* (*Ea*) were initiated at two sites near CDCS in early August. Treatments included one isolate each of *Trichoderma* sp. and a bacterial isolate, either alone or combined with Maxim and a Maxim treatment alone. The pathogen, the granular fungicide, and the biocontrol agents (*Trichoderma*, bacteria) were incorporated into the soil while the seedlings were being transplanted. In both fields, all treatments, especially for the combination of *Trichoderma* sp. and Maxim significantly improved seedling survival compared to the control treatment. Winter survival data will be collected early next spring.

Control of aster yellows of echinacea

Eight essential oils were sprayed separately onto *Echinacea angustifolia* (*Ea*) plants in a field trial near CDCS to control aster yellows (AY). Plots were sprayed weekly between early May and the end of August. Plants sprayed with neem oil had the lowest AY incidence (1.6%), compared with plants without oil spray, which had the highest incidence (7.5%). Plant mortality, probably due to winterkill and/or infection by *Ss*, ranged from 43.2 to 52.2 per cent in all treatments. In a separate field study, Rotenone, Sevin and Malathion were applied on a weekly basis to control AY. Plants sprayed with Sevin had the lowest disease incidence (2.2%), while the non-sprayed control treatment had the highest (6.9%). In the third trial, mint and tansy were used as companion crops, in conjunction with essential oil sprays, to control AY at CDCS. The subplots consisted of four rows of echinacea, which alternated with five rows of companion crops. Garlic, mint or neem oil was sprayed onto *Ea* plants on a weekly basis from the first week of May until the end of August.

Both oil sprays and companion crops provided *Ea* plants with good protection from leafhopper feeding, since only a very low incidence of AY infection occurred among all treatments except the control (without spray and without companion plants). However, the tansy and mint plants grew vigorously, sealed the canopy quickly, and competed with echinacea plants for nutrients, space, light and soil moisture. As a result, many of the *Ea* plants were stunted and only a few reached the flowering stage at the end of the second year of growth. *Ea* should be more widely separated from companion crops in order to get harvestable roots in the third year of growth.

Biological control of sclerotinia root rot of coneflower

Studies on the control of *Sclerotinia sclerotiorum* (*Ss*) on *Echinacea angustifolia* (*Ea*) using *Trichoderma* sp. were conducted under growth chamber conditions. Twenty-five isolates of *Trichoderma* sp. were tested for potential to damage echinacea seedlings. Most of these isolates significantly reduced plant mortality, compared to the unamended control treatment. The lowest mortality of seedlings occurred in the soilless mix amended with isolate 01-91. In another trial, this *Trichoderma* sp. isolate was incorporated into 650 g lots of soilless mix at various concentrations, along with *Ss*, to determine the optimum concentration of bioagent to control sclerotinia seedling blight. The three highest concentrations of *Trichoderma* sp. significantly improved seedling survival compared to the control treatment. When *Trichoderma* sp. was used to control the disease in Echinacea plants at 4, 8, and 16 weeks old, the *Trichoderma* sp. amendment significantly reduced the mortality of plants compared to the untreated control. Seedlings were more vulnerable to the disease at 16 weeks old than at four weeks. Trials will be repeated for verification of the results. Verified information should be very valuable to echinacea growers who are practicing organic farming systems.

Biological control of Pythium root rot of coneflower

Studies on the control of Pythium root rot on *Echinacea angustifolia* (*Ea*) using *Trichoderma* sp. were also conducted under growth chamber conditions. Twenty-four isolates of *Trichoderma* sp., along with Apron and Maxim, were screened for efficacy against seedling damping-off caused by *Pythium*. For pre-emergence damping-off, nine isolates of *Trichoderma* sp. significantly reduced plant mortality, compared to the control treatment. The lowest mortality of seedlings occurred in the soilless mix amended with

isolate 01-091. For the post-emergence damping-off, 14 isolates of *Trichoderma* sp. significantly reduced plant mortality compared to the control treatment. The performance of *Trichoderma* sp. isolates equalled or exceeded the fungicide treatments. In another trial, each of five *Trichoderma* sp. isolates at various concentrations was incorporated into soilless mix (500g) inoculated with 10g *Pythium* grain inoculum to determine the optimum concentration of bioagent to control *Pythium*. Isolate 01-003 had the lowest level of pre-emergence damping-off. Excessive amounts of *Trichoderma* in the soil may have a detrimental effect on the establishment of echinacea seedlings when *Pythium* is present in the soil.

Etiology and microflora of stolon/rhizome rot of mint

Fifteen fields of Scotch spearmint and peppermint were sampled for stolon and rhizome rot from Arrowwood, Bow Island and Carmangay in the spring of 2001. Approximately 336 fungal isolates were isolated from diseased tissues. The majority of the isolated microorganisms were *Fusarium* spp. Other organisms isolated included bacteria, nematodes, *Rhizopus* spp. *Helminthosporium* spp., *Penicillium* spp., *Pythium* spp., *Sclerotinia* sp., and *Rhizoctonia solani*. Fifteen representative isolates were tested for their pathogenicity on Scotch mint under greenhouse conditions and induced severe wilting or death. Six isolates *Rhizoctonia solani*, five isolates *Sclerotinia sclerotiorum*, two isolates *Fusarium* spp. and one isolate *Pythium* sp. showed strong virulence to mint seedlings. Among them, all of the *Rhizoctonia solani* isolates caused 100 per cent seedling mortality.

Responses of 27 *Mentha* spp. cultivars to four isolates of *Rhizoctonia solani*

Twenty-seven mint cultivars were tested for their resistance to four isolates of *R. solani* (nos. 4-17-1, 4-17-3, 4-17-6 and 4-17-4) under greenhouse conditions. The stolons were rated for disease severity one month after inoculation. Isolate no. 4-17-6 caused the highest mortality rate, 47.0 per cent. Isolates 4-17-4, 4-17-1, and 4-17-3 produced a mortality rate of 6.7, 7.1, and 22.1 per cent, respectively. The most resistant cultivars were orange mint [*M. aquatica*, cv. Citrata (*M.* x *piperita citrata*)], applemint (*M. suaveolens*), USDA *Mentha* 552 (*M.* x. *rotundifolia*), pineapple (*M.* x *suaveolens* cv. Variegata), Jamaican (*Micromeria viminea*), and Austrian (*M.* x *gracillis*). The most susceptible cultivars were silver mint (*M. longifolia*), ginger mint [*M. arvensis* cv. Variegata (*M.* x *gentillis*)], Coriscan mint (*M. requienii*), USDA *Mentha* 549 (*M. pulegulch*), and Spearmint-Pan Oil. Resistant cultivars obtained from this trial could be used as breeding materials or incorporated into an integrated disease control program.

Chemical control of Fusarium and Rhizoctonia root rot of peppermint

Seven fungicides were tested for their efficacy to control root rot of peppermint seedlings grown from cuttings. Seedlings (3-5 cm tall) were transplanted into pots inoculated with *Fusarium* sp. (isolate C43) or *Rhizoctonia solani* (isolate A4). The fungicides Benlate, Botran, Easout, Maxim, Terraclor, Rovral and Tilt were assessed as soil drenches for control of the disease under greenhouse conditions. Undrenched and inoculated plants served as control treatments. Plants in the untreated check inoculated with *Fusarium* had a significantly higher disease incidence and severity then plants treated with Easout, Tilt and Terraclor. All fungicidal treatments significantly reduced the incidence and severity and seedling mortality of mint compared to the *Rhizoctonia/Fusarium*-inoculated control. Disease incidence in plants drenched with Benlate, Botran or Easout was significantly lower than disease incidence in the other fungicide treatments.

Diseases of Vegetable Crops

Clubroot of cabbage in Leduc, Alberta in 2001

Clubroot of Su choy cabbage occurred in a major vegetable grower's farm near Leduc in the fall of 2001. Lower leaves of infected plants became yellow. Infected plants also became stunted, leaves were smaller, wilted, heads failed to form and some plants died. Roots of infected plants were deformed into a spindle-like or club-like structure and

became substantially enlarged with few adventitious roots attached. Clubroot is caused by a soil-borne fungus *Plasmodiophora brassicae*, which is an obligate parasite. The heaviest infection was centered in a four-acre area of the field, but neighboring bok choy plants were also infected in several scattered spots in the same field. Root samples collected from that field will be used as inoculum to determine the susceptibility of other cabbage cultivars and cruciferous species.

Diseases of Forage Crops

Method of seedbed preparation affects establishment and stand productivity of alfalfa

Soil-borne fungi may damage alfalfa stands establishment by killing seedlings and plants weakened by environmental stresses. Three field trials were conducted in central Alberta in cooperation with Dr. S.F Hwang at ARC. Alfalfa plots inoculated with *Fusarium* spp., *Plenodomus* spp. or a non-inoculated control were used to compare the effect of conventional vs. sod seeding and spring vs. fall-dormant seeding, on establishment, survival and productivity of alfalfa stands. Plants grown directly in sod were more prone to winterkill during the first winter and grew less vigorously compared to plants grown on conventionally tilled land. Seedling establishment was lower in treatments seeded in the fall, but in some cases these treatments produced similar or higher yields than spring-seeded plots. Inoculation with pathogens consistently reduced seedling establishment, occasionally reduced stand density, but rarely influenced forage yield.

Role of cutting frequency and genetic resistance in prevention of winter injury of alfalfa by the cottony snow mold pathogen

The combined effects of snow mould and low temperature injury constitute the primary causes of winterkill and stand decline of alfalfa in the northern Canadian Parkland. The field trial was conducted in central Alberta in cooperation with Dr. S.F Hwang at ARC. Alfalfa cv. Rambler exhibited the greatest level of cold hardiness and cv. Barrier the least, as measured by an LT_{50} test of 12 cultivars. Inoculation of plants with *Plenodomus meliloti* (the cottony snow mold fungus) reduced overwinter survival by 50 per cent. The cultivars Peace, Algonquin and Heinrichs exhibited the highest percent survival and regrowth following snow mould attack, while Thor, Trumpeter and Rambler exhibited the lowest. Where field-grown alfalfa cultivars were transplanted and incubated with the snow mould fungus, cvs. Apica, Beaver and Peace exhibited the highest percent survival and regrowth, while Anik and Thor exhibited the lowest. Development of the root system was reduced, and stand decline and root rot severity increased with increased clipping frequency.

Technology Transfer Services

Program staff spoke at five growers' and professional meetings in 2001. In this period, two refereed scientific papers, six abstracts, one extension article, four research reports (AARI & CABIDF), and 22 Pest Management Research (PMR) reports were published. Staff were involved in the activities of several professional societies and advisory committees.

Assistance was provided to 20/20 Seed Labs to diagnose several plant disease specimens. Program staff provided advice on disease identification and management to Centre staff and growers as requested.

R.J. Howard retained an Adjunct Professorship in the Department of Agricultural, Food and Nutritional Science at the University of Alberta. K.F. Chang served as a member of the Prairie Registration Recommending Committee for Grain (PRRCG) and was chairperson of the vegetable diseases subcommittee on the Western Committee on Plant Disease.

Post-Harvest Technology Program

J.D. Holley

The primary objective of the post-harvest technology program at CDCS is to maximize the longevity and quality of stored horticultural crops. Research and extension efforts are directed towards improving storage management practices used in industry today. Each year the program screens advanced breeding lines from the Western Canadian Potato Breeding Program (WCPBP) for levels of resistance to early blight, verticillium and fusarium wilt and a range of storage diseases and physiological disorders.

The program worked on two special projects last year. Potatoes were received from five provinces for post-harvest testing last winter. The purpose of the trans-Canada experiment was to determine if applying the new fungicide Gavel to vines during the growing season reduced levels of storage decay after harvest. The program also held a bacterial ring rot (BRR) workshop last summer, the first one held at CDCS in over a decade.

Research Projects

Field trials

Early blight resistance screening of advanced breeding lines

Small plots of eight standard cultivars and 38 advanced breeding lines from the WCPBP were established in a randomized, complete block design with four replicates in soil that was heavily infested with spores of the early blight fungus, *Alternaria solani*. Levels of blight were recorded six times during the growing season and observations were used to construct apparent infection rates. Infection rates were used to categorize each test line. One line (CV75-5-297) was more resistant and three (FV10996-12, Russet Norkota, and V0865-1) as resistant as the standard, Russet Burbank. Three lines (CV89075-1, Norland and V0123-25) were as susceptible and two (CV94048-7 and Yukon Gold) more susceptible than the standard Warba.

Early blight survey and aggressiveness testing

A new aggressive strain of *A. solani* may be responsible for the sudden increase of early blight seen in many commercial potato fields over the past several summers. Leaves with early blight lesions were collected from 86 farms from across Alberta. Pure isolates of *A. solani* were recovered from every field surveyed. Spores from each culture were used to inoculate single leaves of greenhouse grown blight-susceptible potato (cv. Warba). Lesion sizes recorded two weeks later were used to characterize the aggressiveness of each isolate. Results were included in a final AARI report for this project.

Evaluation of two fungicides for the control of early blight

A four replicate, randomized, complete block design trial was planted last spring at CDCS to test the efficacy of two dosages of the new fungicide azoxystrobin (Quadris), and two formulations of the fungicide chlorothalonil (Bravo 500 and Bravo Ultrex) against early blight. Levels of early blight were marginally higher in the unsprayed check than in plots sprayed with highest dosage of Quadris or with Bravo 500. Levels of early blight were quite low due to high temperatures and a lack of rainfall during the growing season. There were no differences in row weight, distribution of size or specific gravities between treatments at harvest. A final report summarizing all results from these tests was forwarded to Syngenta to support their application for the registration of Quadris.

Verticillium wilt resistance screening of advanced breeding lines

Virulent cultures of two potato wilt pathogens, *Verticillium albo-atrum* and *V. dahliae,* were grown on barley seed three weeks prior to being used to inoculate seed at planting. Two cultivars and ten advanced breeding lines were planted along with infested grain in an eight replicate, randomized, complete block field trial. Fifty tubers from each replicate were cut and examined for evidence of vascular browning from wilt infection after harvest. Percentages of tubers with symptoms were recorded and means calculated for each line. Two lines (FV10459-8 and V0498-1) were more resistant and three (CV89024-1, V0498-9 and V0742-1) as resistant as the standard Russet Burbank. One line (V0404-4) was more susceptible than the standard Shepody.

Verticillium wilt resistance screening of transgenic lines

Three transgenic and one unmodified line of potato cultivar Desiree, were inoculated with *V. albo-atrum* and *V. dahliae* last spring using the method described above. The field trial had to be established in a plot that had never been inoculated with infested barley seed before because of a rotation restriction imposed on genetically modified crops by the Canadian Food Inspection Agency (CFIA). Unfortunately the inoculum density in the new plot was so low that there were no differences in levels of vascular wilt between any of the transgenic lines and the unmodified cultivar Desiree. It will be necessary for researchers to negotiate with the CFIA to have the rotation ban lifted to improve the reliability of this field trial.

Fusarium wilt resistance screening of advanced breeding lines

A virulent culture of *Fusarium oxysporum* was established and used to plant and inoculate two cultivars and 10 advanced breeding lines in a second wilt screening trial using the method described previously. Four lines (CV89024-1, FV10459-8, V0498-1, and V0498-9) were as resistant as the standard, Russet Burbank. One line (V0717-1) was more susceptible than the standard Shepody.

Evaluation of seed piece treatments for the control of rhizoctonia black scurf

A four replicate, randomized, complete block design experiment was planted to test the efficacy of three new fungicides, Gaucho, Quadris, and Tops MZ Gaucho, for controlling tuber borne black scurf caused by *Rhizoctonia solani.* Application of three new seed piece treatments effectively reduced levels of rhizoctonia black scurf on daughter tubers. Results from this trial will be used to support the registration of each new fungicide.

Storage trials

The consortium storage trial for processing quality and disease resistance

Breeding lines from the WCPBP were harvested then transported to CDCS for post-harvest tests. Potatoes were loaded into CES rooms with stable storage conditions at 6°, 8° or 10°C. Samples are now being taken from each CES room every two months to determine effects of temperature on chip, french fry, baking and boiling color and texture. Potatoes from the WCPBP are also being stored in a CES room with fluctuating levels of temperature and humidity to see how resistant they are to a wide range of storage diseases and physiological disorders. This trial is in progress so there are no results to report at this time.

Evaluation of a new fungicide for the control of pythium leak decay

Last year the post-harvest program received potatoes from replicated field trials in five provinces (BC, MB, ON, PE and QC) for post-harvest testing of the new fungicide Gavel. The primary purpose for the tests was to determine whether the application of fungicide sprays during the growing season had any effect on tuber resistance to the leak pathogen after harvest in controlled inoculation tests.

Potatoes were harvested from plots that were either sprayed with Gavel alone or with alternating applications of Gavel and Dithane showed significantly less decay six weeks after inoculation compared to potatoes from unsprayed check plots. Gavel is a contact

fungicide which does not translocate downward from leaves to underground tubers. The reduction in levels of decay is not being caused by build up of fungicide in tuber tissues. The reason for this treatment effect is not clearly understood. Results from this trial will be used to expand the new label for Gavel.

Evaluation of a new disinfectant for the control of storage diseases

Last winter the post-harvest program received over eight tons of commercially grown Alberta potatoes from industry for post-harvest storage experiments. The purpose of the post-harvest tests was to determine whether a new disinfectant, chlorine dioxide (Purogene), was effective in controlling skin blemishes and storage decay. Application of the product at the label rate did reduce levels of rhizoctonia black scurf but failed to control other skin blemish diseases (e.g. helminthosporium silver scurf). The chemical also failed to reduce levels of storage decay (e.g. fusarium dry-rot or pythium leak).

The timely application of the product was delayed by late funding and uncertainty regarding the registration of the product in the fall of 2000, so it is not clear whether the disinfectant actually works or not. Unfortunately application of chlorine dioxide did cause significant surface corrosion of some metals (e.g. brass, copper and raw steel). Other more resistant metals (e.g. aluminum, galvanized or stainless steel) did not appear to be affected.

Disinfectants like chlorine dioxide have never been used in storage before so all of the risks and benefits associated with their application are not fully appreciated at this time.

Technology Transfer Services

Routine telephone queries about potato and vegetable diseases and storing potatoes and other garden vegetables were dealt with as they arose. The chemical company Syngenta sponsored a number of industry tours at CDCS, allowing J. Holley a unique opportunity to participate in industry sponsored seminars. He also was able to show growers, chemical representatives and others involved with the potato industry what the post-harvest program is doing.

J. Holley was instrumental in the organization of the BRR orientation seminar which was held at CDCS, this included doing inoculations of potato plants for the hands-on part of the seminar. Although BRR is a declared pest, it has largely been eradicated so inspectors have rarely seen symptoms of the disease in the field.

Results from Purogene trials from the 2000-2001 storage season were simplified and summarized in three tables for a poster display for the Potato Growers of Alberta's annual meeting. Manitoba professionals, working with potato growers, have requested permission to use the data tables and pictures from the poster display in their extension program this winter.

J. Holley continued as chairman for the potato chapter for the Western Committee on Plant Diseases (WCPD). The WCPD potato chapter was extensively revised this year, the first time in a decade. Holley continues to participate on the Alberta Potato Research Committee (APRC) and on the Storage Committee of the Prairie Potato Council (PPC). He revised a chapter on storage management for the PPC.

Soil and Water Agronomy Program

R.C. McKenzie, S.A. Woods and L. Hingley

The soil and water agronomy program conducts research on water, fertilizer and sustainable soil quality requirements of special crops, horticultural crops and irrigated forages. Some research projects were done cooperatively with staff from other programs at CDCS and other divisions of AAFRD. Soil samples were analysed by AAFRD's Soil and Crop Diagnostic Centre, Edmonton. Engineering assistance was received from the Alberta Farm Machinery Research Centre (AFMRC). Research funding was provided by: Potato Growers of Alberta; Westco; Southern Agri Services; Pan Canadian Petroleum; and McCains. Producers J. Rozendaal of Hays, C. Perry of Coaldale, and K. Sikkens of Barnwell cooperated with field research projects.

Research Projects

Precision farming

Site-specific management of potatoes

Site specific management involves applying adjusted amounts of inputs such as water, fertilizers and herbicides, as required, to different portions of a field. This is now feasible using Global Position System (GPS) controlled equipment such as fertilizer applicators or herbicide sprayers. At a less technical level it can be done by subdividing the field into different units and applying different inputs to each subdivided unit.

This project began in 1996 and will conclude in 2001. The objectives are:

- to measure and map yield variability within a field
- to determine the effects of soil type, landscape position, soil fertility, diseases and weeds on potato yield
- to determine the variability in yield of preceding crops, and to relate this to field variability and tuber production
- to measure the cost benefits and environmental influences of site-specific management
- to evaluate the use of remote sensing and digital image analysis of fields to detect nutrient deficiencies and diseases of potatoes

Two, 27 ha potato fields were monitored in detail. One was irrigated with a centre pivot and the other with a corner pivot. Soil texture was determined at 50 sample points, and at these points rainfall, irrigation and soil moisture records were taken. Plant petiole samples were taken three times during the growing season for nutrient analysis. Yield data and remote sensing imagery were also collected and compared to soil and crop characteristics to explain what caused variations in yield.

The data showed soil texture, tissue nutrient content and the available soil moisture status of potato fields were quite variable. Tissue phosphorus and nitrogen declined rapidly during the growing season in portions of the potato fields. The potatoes were deficient in tissue potassium in early July, in the first three years (1996-1998) but not in the fourth year (1999) on both fields. There was adequate potassium on both fields at the end of July and in August. Low soil temperature is known to reduce the uptake of potassium, however, June and early July of 1999 had below normal temperatures and 1998 was above normal.

Tuber size and specific gravity was related to water application with fewer and larger tubers in the areas which received insufficient water as compared to areas with adequate water. This was the most important factor controlling yield and quality of tubers.

Tissue nitrogen was significantly positively correlated to soil nitrogen on three out of six fields. However, when the data from all six fields was combined there was no significant relationship between tissue NO_3-N and soil NO_3-N. However, tissue NO_3-N was significantly positively correlated to soil clay % in the 0.0-0.60 m layer. This means it would be more useful to base precision applications of nitrogen for potatoes on soil clay content rather than on soil NO_3-N content. This still leaves unresolved the fate of the NO_3-N on the soils with low clay content.

Tissue phosphorus for six fields was found to be significantly positively correlated to

available soil phosphorus and significantly negatively correlated to soil clay content. This means that available soil phosphorus can be used to determine precision applications of phosphorus. Some of the soil phosphorus is held in unavailable forms on soil clay.

Yield was determined on strips which received various rates of nitrogen and phosphorus fertilizer and were compared to yields obtained from the farmer's fertilizer rates. In the fall of 1998, two rates of each of compost, manure and phosphorus were applied to one field. Manure and compost, as compared to phosphorus fertilizer, were found to significantly reduce the number of diseased plants and had no effect on the amount of rhizoctonia and scab on tubers. This is a positive result towards use of manure and compost as it indicates they do not increase diseases in potatoes and in some cases, may reduce the occurrence of disease.

Soil Fertility

Phosphorus Requirement of Potatoes

Southern Alberta's expanding irrigated potato industry is expected to reach about 18,200 ha (45,000 acres) by 2001. This will require rotations involving about 73,000 ha (180,000 acres).

The ability of potatoes to use phosphorus (P) is lower than many other crops meaning they require more phosphorus fertilizer than most other crops. The P recommendations for potatoes in Alberta have been based on maximum applications of 40 kg/ha P (80 lbs/ac of P_2O_5). New recommendations developed in NW USA suggest maximum rates of 200 kg/ha P (P_2O_5 at 400 lbs/ac) on low lime soils and 256 kg/ha P (525 lbs/ac P_2O_5) on high lime soils. Alberta producers are uncertain what rates to use.

Manure and compost are high in P content. Disposal of manure and manure compost often takes place near the manure source. This creates situations where the soils accumulate excess P and contribute P to surface water. Most of Alberta's lakes and rivers within agricultural areas already contain excess levels of P and nitrogen. Alberta potato farmers are reluctant to use manure as a fertilizer because they believe it may contribute to potato scab and an increase in weed seeds. They are unfamiliar with compost, which has only become available in larger quantities since 1999. If manure and compost are proven to be a satisfactory source of P for potatoes, this will aid in alleviating an environmental problem.

In 2000, three P experiments were set out. The field scale experiments had five rates of P from 0 kg/ha to 200 kg/ha and three rates of compost from 9 tonnes/ha to 36 tonnes/ha. Tissue nutrient levels, yield, tuber size, specific gravity and hollow heart were determined on both experiments. Increasing the rates of P above 25 kg/ha had no significant effect on yield. In the first experiment tuber size was slightly reduced on treatments receiving high rates of P.

Applications of Drilling Muds to Agricultural Lands

Several types of drilling mud were applied to irrigated and dryland crops and to grassland at three rates to determine its on crop growth and soil quality. Drilling muds containing nitrogen were found to increase the nitrogen content of grains and forage grasses. Drilling muds were not found to have negative effects on growth of barley, forage grass or native range.

Site Specific Application of Fertilizer N for Reducing Greenhouse Gas Emissions

This project began in 2000 in collaboration with G. Kachanoski, University of Saskatchewan; I. O'Halloran, University of Guelph; R. Simard, AAFC—Ste Foy, QC, and D. Rolston, University of California, Davis.

Current estimates of nitrous oxide (N_2O) emissions account for over 50 per cent of greenhouse gas emissions from agriculture. However, factors controlling N_2O emissions from soil are poorly understood. It is known that crop requirements for nitrogen vary significantly within fields. However, a majority of fields have a constant rate of fertilizer applied to them. Methods have been developed using GPS (ie. site specific or precision

applications) to apply variable rates of fertilizer throughout the field. This project will measure the influence of site specific applications on reducing N_2O emissions. Excess applications on N fertilizer above levels which increased crop yield were found to increase gaseous emissions of NO_3.

Technology Transfer Services

Soil and water information was provided to a diverse audience through scientific papers, technical reports and research publications. Presentations were made at technical conferences and producer meetings; inquiries were answered through telephone contacts, office visits and correspondence. Frequent inquiries were received about the suitability of water quality for use in irrigation.

Information on crop tolerances to salinity and methods of measurement were provided to various groups. Research results on the use of phosphorus and compost on potatoes was presented to potato growers and soil specialists. A Pakistan soil specialist visited CDCS for a short course on measuring and mapping soil salinity.

Special Crops Program (Edmonton)

S.F. Blade, N. Clark and L. Maskewich

Alberta producers are interested in diversifying their production. This was true in 2001 as prices for several conventional crops continued to tumble. One successful strategy is to incorporate new crops into the farming system. The special crops program is dedicated to introducing new crops that will contribute to the long-term viability of agriculture in the province. Diversification can contribute to improving crop rotations through inclusion of pulse crops, reduce the impact of price volatility on producers dealing in traditional crops and expand opportunities for value-added processing in Alberta. Both large-scale conventional farmers and less-experienced entrepreneurs who wish to become involved in intensive production and processing opportunities presented for specific new crops are assisted.

2001 was a productive year for the special crops program at CDCN. The breeding and agronomy commitment to pulses and other special crops was expanded.

Research Projects

The special crops program at CDCN has been active in the identification and development of promising economic crops since 1995. The focus has been research on several categories of new crops: pulse, spice, alternate, herb (medicinal, culinary and aromatic) and fibre crops.

Pulse Crops

Western field pea cooperative trial

In 2001, the special crops program entered three second year and four first year breeding lines into the Western Field Pea Cooperative Trial. The line SB2000-2 was the highest yielding line in the Coop Test (14 per cent higher than the average of four check lines) across western Canada. In addition, it has superb powdery mildew and fusarium wilt resistance. This line is set for release in 2002 at the Prairie Recommending Registration Committee for Grains. The new cultivar will be available for commercial production in 2003 in accordance with the memorandum between Alberta Pulse Growers, AAFRD, the Crop Development Centre (University of Saskatchewan) and the Saskatchewan Pulse Crop Development Board.

Field pea breeding and germplasm evaluation

CDC Advance — To jumpstart the field pea breeding program this program was able to collaborate with the Crop Development Centre in Saskatoon to obtain early-generation lines from crosses which were targeted to the cool, moist conditions of Alberta. Following original unreplicated screening in 1996, a replicated preliminary yield trial was conducted in Edmonton and Grande Prairie in 1997. The elite material was put into an ongoing yield test in several locations in Saskatchewan and Alberta.

In 2000, a formal agreement was signed between the Alberta Pulse Growers Commission and the University of Saskatchewan pulse breeding programs to ensure that superior genetic material will be available to farmers in each province. These commissions have guaranteed long-term funding for the CDCN breeding program; and discussions are underway to include lentils and chickpeas into the agreement.

AAFRD/AAFC Breeding Agreement — In 1997 an agreement was signed between CDCN and the AAFC-Morden Field Pea Breeding Program. Approximately 200 lines were tested in 2000; the best lines will be determined and evaluated and by multilocation testing in 2001.

CDC North — 2000 pea lines crossed in the greenhouse were planted in the field for the 2001 growing season. This new material will be evaluated with several objectives in mind: plant maturity, height, harvestability, plant architecture, disease resistance, seed vigor, and yield.

CDCN also collaborated with the University of Saskatchewan's pulse breeding program to increase seed yield of pea, bean, lentil and chick pea lines numerous selections from the World Germplasm Bank were planted to examine pea lines that have economic potential as a sound agriculture crop for the region. The expectation is to use the Germplasm Bank to identify high-vigor genotypes that can be incorporated into the breeding program in the future.

Intensive pea management (IPM)

The IPM Trial was originally set up in 1998 to evaluate the impact of four major management issues in the production of field pea across Alberta. Preliminary results indicate that rate of seeding and date of fungicide application were the two important variables affecting this study, which led to a shift in focus for the 2000 season, allowing program staff to concentrate on issues that have a direct affect on the growers. In 2001, several locations were grown to increase the dependability of the data. Several presentations, including at the North American Pulse Improvement Association have been delivered.

Field pea inoculant trials

The second year of this experiment in collaboration with AAFC-Lacombe and AAFC-Beaverlodge was conducted in 2001. The basis of the experiment was to determine the effects of inoculant formulations on nodulation (the symbiotic relationship between *Rhizobia* spp. and legumes).

New millennium silage trial

2001 was the second year for the new millennium silage trial. This experiment was conducted at five locations across Alberta (Vermillion, Barrhead, Lamont, Grande Prairie, and Edmonton). The purpose of this trial was to look at protein content of grain and field pea intercropping at flat pod stage. The treatments incorporated varying levels of a cereal (barley or triticale) and Swing or Performance 4010 field pea.

Pulse crop screening (lentil, faba bean, chickpea)

In collaboration with several seed companies and breeding programs lentil lines were tested in Vermilion (in cooperation with Terry Buss), chickpea lines and faba bean (at CDCN). In collaboration with Randy Bjorklund the silage potential of 10 faba bean lines was assessed by collecting data on biomass production and feed analysis. In collaboration with CDCS and AAFC-Lethbridge personnel four excellent fenugreek lines were identified that have good nutritional composition and maintain forage quality until late in the season.

Fibre Crops

Low-THC hemp research

In 2001 low-THC hemp research continued at three locations (Fairview, CDCN and Bow Island). Rate of seeding- and varietal- trials were conducted to support potential industry development using this crop.

Technology Transfer Services

Due to the high interest in special crops, staff was called upon to answer numerous enquiries regarding a range of new crop opportunities relating to pulse, spice, medicinal and fibre crops. Staff contributed articles on crop diversification and species-specific topics to producer newsletters, industry periodicals and provincial newspapers. The interest in crop diversification resulted in several media interviews that were the source for further enquiries from the general public.

The demand for increased knowledge regarding new crops resulted in courses, seminars and field tours. The Special Crops Field Day held at CDCN was a tremendous success; and the total number of tour participants throughout the year totaled more than 1000 individuals. CDCN staff also assisted members of the Pulse and Special Crops Team with obtaining planting materials for demonstrations across the province, and distributing technical information to clients.

A new innovation was involvement in Ask The Expert and Agri-Ville electronic forums provided an opportunity for staff to interact directly with producers in a new and highly effective forum. Clients included producers, other AAFRD Units, universities, AAFC, other provincial agriculture departments, applied research associations and agri-industry. An interesting component of the work was many of the trials were done as researcher-managed on-farm experiments, which allowed neighbors to view technological innovations in their own area. Program staff served as college and university guest lecturers, independent study course mentors (U of A) and resource people for a number of industry organizations.

The special crops program would like to acknowledge the contribution of Jackie Tieullie, Jo-Ann Berry, Leah Maskewich, J. Teulie, R. Bok-Vischer, M. Essensa for their assistance in 2001.

Special Crops Program (Barrhead)

K.J. Lopetinsky

Crop diversification by incorporating pulse crops in the rotation is greatly benefiting producers with greater stability of income and new marketing strategies. Development of value-added processing will enhance these benefits. As team leader of the Pulse Canada Research Agronomy Committee, much effort was spent on developing a National Pulse Strategy with full support from the producer organizations of four provinces. This strategy will form the basis of future developments in genetics, agronomy, quality and sustainability across Canada. The present pulse research program at Barrhead continues to grow and the team includes partnership of AAFRD (Pulse and Special Crop Specialists, Agronomy Unit, CDCN, CDCS) AAFC-Lacombe, ARC-Vegreville and the University of Alberta (U of A). As well, key participation from Alberta Pulse Growers (APG) - Central and Zones and various private pulse industry partners (AB, CA and International) has further enhanced the team. Research emphasis in 2001 continues to be on field pea and fababean agronomics with a future emphasis on quality effects and value-added projects.

Research Projects

The AAFRD team with APG and private industry participated in a total of 21 projects this year. Research priorities and projects were developed in consultation with industry and were coordinated by K.J. Lopetinsky with assistance from APG-Zone 3 staff: Glen Pullishy, Sheryl Strydhorst, Tanis Wagner and CDCN (contract) Maureen Essensa. Key additional partners included S.F. Hwang, ARC; J. King and L. Dosdall, U of A; N. Harker and G. Clayton, AAFC; and numerous industry specialists.

Fababean graduate research project

Partnership developed with APG-Zone 3 and J. King, Plant Science, U of A to sponsor Sheryl Strydhorst as a M.Sc. candidate with NSERC industry sponsorship from APG-Zone 3 and supervision by J. King, J.P Tewari and K.J. Lopetinsky. Field studies on Tannin Free Fababean Agronomics conducted in 2001 in the APG-Zone 3 area at two locations.

Western Canada field pea cooperative trial

One of the 12 sites across Western Canada is maintained at Westlock, representing a total of 50 new cultivars from Canadian and European Breeding institutions. Complete agronomic data, yield, and samples for food quality analysis were collected and submitted to Morden, MB. Results are published in the *Prairie Registration Recommending Committee for Grain-Special Crops Subcommittee Report* (annual). Data is used to support CFIA registration of new field pea cultivars. Advisory role as member of Special Crops breeding and agronomy subcommittee.

Alberta regional pulse trials

Advisory role as member of Alberta Pulse Regional Testing Committee (ad hoc) which has developed a provincial testing program with monetary support from APG, AAFRD and sponsoring seed companies. The Barrhead program conducted field pea trials (green and yellow) at two locations as part of the Area 3 data for the provincial program. Results are published annually in Agdex 140/32-1 *Varieties of Special Crops of Alberta*. In addition, coordinated fababean trials with Collin Wildschut, CDCS at four locations. These trials included new fababean genetics from France and the Netherlands with Canadian sponsors Roy Legumex, MB and St. Denis Seed, AB.

Pre screening and evaluation of new pea genetics

In partnership with Cebeco Zaden (The Netherlands) a total of 20 lines of yellow, green and marrowfat field peas were evaluated at four locations with location support from R. Bjorklund, AAFRD and Robyn Russel, Agricore. In addition, Plant Breeders Rights (PBR) tests and descriptions were conducted at two locations for Advanta and Cebeco on eight field pea candidate cultivars and two fababean candidate cultivars against recognized reference cultivars. This is a two-year data collection and variety description funded by sponsoring industry.

Fababean agronomy and genetic improvement

Expansion of fababean research included the joint venture with U of A (M.Sc. candidate sponsorship), work with BASF on herbicide efficiency on fababean and evaluation of new genetic material from France and the Netherlands. Further expansion of value-added processing fababeans initiated with C. Phillips and M. Eliason for 2002.

Pea inoculant research program

Year two evaluation of biological signal molecule inoculants for field pea and lentil at CDCN in partnership with AAFC, Dr. George Clayton team leader and Bios Agriculture (QC). Evaluation of new field pea rhizobium strains and comparison of various formulations for optimum nitrogen fixations and yield continued in partnership with Microbiorhizogen (Saskatoon, SK) and PhilomBios (Edmonton, AB). Evaluation of phosphate fertilizer and blends on granular inoculant viability when mixed was supported by LiphaTech. Time intervals of the granular inoculant and fertilizer mixtures included 0, 1, 2, 3 days and yield comparisons evaluated both with and without the added fertilizer in the seed row. Two years of data are very positive for these mixtures.

New millennium silage trial

In partnership with Pulse and Special Crops Specialists, four locations were seeded, CDCN, Barrhead, Vermilion and Grande Prairie to compare seeding rate of barley and spring triticale with Swing and Performance 4010 field pea as sole crop and intercrop mixtures. Biomass yield and crude protein determined for 16 treatments at each location. This program was developed at Barrhead where all seed ratios and seed sub plots determined and supplied to other locations. In addition, preliminary work in partnership with Quality Assured Seeds was initiated at Barrhead to compare new cereal genetics intercropped with Swing and Performance 4010 field pea.

Evaluation and special purpose field pea cultivars

Expansion of this project on evaluation of 20 cultivars of various niche field types to eight locations throughout Alberta. Agronomic data was collected with comparisons to a standard yellow and green pea cultivar. Various green and brown marrowfat, maple, orange cotyledon, white cotyledon and other types of peas represent a niche market and value-added processing opportunity. Presently, at least three companies have started developing actual value-added niche markets.

Ascochyta disease control in field pea

In partnership with Dr. S.F. Hwang, ARC-Vegreville, and industry support from BASF and Syngenta resulted in completion of a three-year study of Bravo® rates and timing evaluation on control of Ascochyta as well as work on a new BASF fungicide, Headline at two locations. This data was used by BASF in developing their new production bulletin on Headline.

Field pea research partnership with Alberta pulse growers—Zone 3

A research review of pulse priorities with Zone 3 and attention to the Pulse Canada Research-National Strategy has resulted in developing three new projects for 2002 based on the Agronomy Strategy of pulse quality improvement through production systems. The projects include work on field pea: quality affects of harvest management factors, quality affects of marrowfat peas through seed and desiccation management and quality affects of genetics of new pea varieties.

ACIDF pulse research development 2002

As part of a provincial pulse team, full ACIDF proposals have been developed on three programs: developing a fababean industry, pulse products development and suitability of new pulse crops. In addition partnership in ACIDF projects on value-added processing of chickpea with M. Eliason and C. Phillips and partner on pulse seed compositional data study with C. Phillips.

Technology Transfer Services

An expanded team approach has resulted in more technology transfer opportunities. Three posters and proceeding abstracts developed on millennium silage project, Ascochyta control in field pea and evaluation of special purpose pea cultivars were presented at three major conferences: Western Canada Agronomy Workshop, Lethbridge, Pulse Days 2002, Saskatoon and FarmTech 2002, Red Deer. In addition, team members presented results at APG Zone annual meetings. Development of year two pulse and new crops modules at Ellerslie Diagnostic School produced excellent results and a new method of technology transfer for many specialists. A total of seven summer tours were resourced with industry partners to see first hand differences in various project treatments of many projects in the area, and some key train the trainer opportunities developed at several tours. Written articles, resourcing of other seminars and radio talks highlighted the pulse industry's new results in 2001. Of special interest is the team approach to develop a computer based pulse and special crops slide and presentation database for future technology transfer opportunities. Completion of this project is within several months.

Special Crops Program (Brooks)

M. Bandara, C. Wildschut, C. Weisbach, L. Russell, J. Webber and T. Simo

The special crops program at CDCS is primarily responsible for the evaluation, introduction and development of alternative or new crops for southern Alberta through applied and adaptive research projects. Some study projects are conducted in collaboration with other research programs at CDCS, other divisions of AAFRD, University of Alberta, University of Saskatchewan, AAFC, Regional Research Associations and industry partners. Different funding sources such as Farming for the Future Matching and Direct Funding Grants, regional and cooperative varietal testing programs and several processing industry partners provide the financial support for the programs.

Agronomic and physiological studies and cultivar development programs are conducted on pulses, herbs and spices, medicinal plants and essential oil crops. A considerable amount of time is invested on new cultivar and species evaluation studies.

Detailed project results are presented in CDCS pamphlet 2001-20, *Special Crops Cultivar Trials.*

Research Projects

Regional/co-op trials

Newly developed breeding lines and promising cultivars of lentils, chickpeas, drybeans, fieldpeas, fenugreek and fababean were received from various crop breeding programs and were evaluated under dry land or irrigated conditions in Alberta, to select suitable cultivars for the region.

Drybean cultivar evaluation and cultural practices

Seven yield tests, with various drybean lines and varieties, were conducted at the Bow Island sub station under irrigated conditions. Information was collected for further evaluation, registration and recommendation purposes. The emphasis in the drybean cultivar testing is on yield performance, early maturity and plant architecture which allows for narrow row configurations, direct combining and consequently an expansion of the present drybean production area.

Breeding programs at the AAFC-Lethbridge, AAFC and the Saskatoon Crop Development Centre at the University of Saskatchewan are developing promising lines of this type of drybean. The Prairie Registration Recommending Committee (PRRCG) for Grains recommended four drybean lines (one black, one pinto and two navy) for varietal registration.

Two irrigated locations in southern Alberta were established to test these newly registered cultivars in wide and narrow row configurations, under the Regional Pulse Varietal Testing Program.

Other pulse crops cultivar evaluation and cultural practices

Seven fieldpea cultivar trials were conducted at Brooks, Bow Island, Strathmore, Three Hills and Barons to evaluate lines/varieties for regional adaptation. Brooks and Bow Island were the only irrigated sites. The PRRCG in 2000 recommended five yellow and seven green type fieldpea lines for varietal registration. Most lines produced higher seed yields than the check varieties, generally were earlier maturing and had acceptable disease resistance and quality characteristics. In 2001, 27 sites were established in different geographic regions and soil zones of Alberta and the Peace region of British Columbia to test newly registered fieldpea varieties.

Different lines and registered varieties of lentils, chickpeas and soybeans, were evaluated for registration and regional adaptation. Six kabuli and six desi type chickpea regional tests were established under dry land conditions at Bow Island, Brooks, Strathmore and Barons. All sites were harvested, but due to severe drought conditions in the southern part of the province, only the Barons site produced good yields.

Chickpea and lentil cultivar development project

The following chickpea and lentil germplasm from the Crop Development Centre, University of Saskatchewan pulse breeding program were evaluated at the Bow Island Substation in 2001.

1. Two chickpea Elite yield trials of which the kabuli trial consisted of 36 entries X 2 replicates, and the desi trial consisted of 24 entries X 2 replicates.
2. Three lentil Advanced yield trials each consisting of 36 entries X 2 replicates.
3. Five hundred forty lentil F3 microplots.
4. Five hundred chickpea F3 microplots.

Chickpea and lentil yield trials. Seedling emergence and crop establishment were delayed or reduced in parts of the Bow Island site that were affected by soil-borne diseases, which were identified by Dr. Kan-Fa Chang (CDCS) as *Rhizoctonia, Ascochyta and Fusarium*. These diseases reduced yield and increased CV's. Efforts have been made to identify more uniform land for 2002 trials.

Lentil F3 microplots. A total of 190 of the 540 F3 microplots were selected for harvest based on plant vigor and desirable growth habit. Using days to emergence, days to first flower, mean plant height, mean seed yield/plant and seed characteristics such as plump shape, 75 of the 190 lines were selected for further evaluation in replicated plots in 2002. These plots will be established at two locations, at Brooks and Bow Island with one replication at each location. Selected lines consisted of several lentil market classes including large green, medium green, small green and red.

Chickpea F3 microplots. A total of 235 of the 500 F3 microplots were selected for harvest based on plant vigor and desirable growth habit. Using the days to emergence, days to first flower, 1000 seed weight, seed appearance and mean plant height, 43 lines of Kabuli-type (including some large and some smaller seed size lines) and 29 lines of the Desi-type were selected for further evaluation in replicated plots in 2002. These plots will be established at two locations, in Brooks and Bow Island with one replicate at each location.

Other special crop cultivar evaluations and cultural practices

Several cultivars and lines of soybeans and silage and grain corn were evaluated for potential registration and regional adaptation.

Fall seeding studies

Fall seeding or dormant seeding refers to the planting of a crop species in the fall before freeze-up. Fall seeding of small-seeded spring crops such as canola is becoming popular among growers in the Prairies because of improvement in crop quality and yield compared to that of spring-seeded crops.

Using the canola seeding model, fall seeding studies were established at CDCS with four spice crop species, anise, coriander, dill and mustard, and at Bow Island Sub Station with two pulse crops, desi type chickpea cultivar Myles and red lentil cultivar Redwing. Different seeding rates (1x, 2x and 4x) and seed-coated with plastic polymers were used as treatments. Growth and yield performances of the fall-seeded crops were compared with spring-seeded crops. The test site at Bow Island was subject to severe wind erosion during the winter; consequently unacceptable plant populations of both pulse crops were produced and the study was abandoned.

At the Brooks test site, all the crop species except anise, established successfully. The crop emergence of both fall-seeded and spring-seeded anise was very low (< 5%), therefore the anise study was abandoned.

Increasing the seeding rate of the fall-seeded, uncoated treatment significantly increased the plant density, particularly at four times seeding rate. There was no impact on the final plant height, fruit yield or crop maturity of coriander. The polymer seed coating did not increase seedling density or extent the planting window in coriander either. On average, the seeding date during the late fall had no significant impact on plant density or fruit yield in coriander. This indicates the crop can be seeded with a wide window in the fall without having a significant impact on the crop stand.

In general, seeding rate of the uncoated fall-seeded treatment had no significant impact on final plant height or crop maturity of dill. However, seeding rate produced a significant impact on fruit yield, in the crop seeded on October 26, no difference was noted with November seeding. This shows a higher seeding rate would provide fruit yield benefits, particularly when the crop seeds in early fall. The polymer seed coat treatment had no significant impact on either plant density or fruit yield of dill.

Overall, mustard plants of the uncoated fall-seeded treatment produced taller plants when grown at higher seeding rates compared to those grown at lower seeding rate. The spring-seeded crop was significantly taller than the fall-seeded crop. Increasing the seeding rate produced an increasing trend in the seed yield, but the effect was significant only in early November seeding. The seed coat treatment produced significantly higher seed yield (more than 52 per cent) than the corresponding uncoated treatment, particularly when seeded in October. On average, the fall-seeded crop produced over two-fold seed yield increase compared to the spring-seeded crop. The seed coat treatment would be beneficial, if the crop seeded in October. The fall-seeded crop can be harvested about one month earlier than the spring-seeded crop, thus early harvest the crop would be the most beneficial impact of the practice.

In summary, results indicate that coriander, dill and mustard can successfully be produced from dormant seeding in southern Alberta. Seeding rates should be increased to two times recommended rate to maintain a satisfactory stand of the crop. Further studies are in progress using anise and other pulse crops such as fababean.

Lentil cultivar/line evaluation for over wintering ability

Fifteen lentil cultivars from the Crop Development Centre, Saskatoon, were seeded at CDCS, in the fall (October 26 and November 2) of 2000. One half of seed of each cultivar was coated with plastic polymer and the other half was uncoated (untreated control). Cultivar and coat treatment effects on winter survival, crop growth and seed yield of fall-seeded lentils were assessed and compared with that of spring-seeded lentils in the 2001 cropping season. Five cultivars/lines were found to be overwintered successfully under the field conditions at Brooks. The plastic polymer treatments enhanced the overwintering of these crops. All these cultivars/lines flowered and matured at least two weeks and three weeks earlier than the spring-seeded crop, respectively. On average, the stand establishment of the late fall-seeded crop was significantly higher than that of the early fall-seeded crop. Seed yields of the fall-seeded lentil lines were significantly lower than that of spring-seeded crops.

Effect of seed size on crop growth and seed yield pinto bean

The size of the seeds planted has been shown to have a significant impact on seedling establishment, seedling vigour and crop growth of several small-seeded field crops such as jute, mustard, coriander and carrot. This impact was not noted in large-seeded crops such as chickpeas. This study was conducted at CDCS to examine the effect of seed size on seedling growth, seed yield and seed size profile of the resulting crop of three pinto beans cultivars, Othello, Fargo and CDC Pintium, under field conditions in southern Alberta.

Results indicated that the bean cultivar had a significant impact on the final plant height, date of first flowering, mean seed weight and seed size profile of the resulting crop, but had no effect on number of seeds plant, seed yield per plant and plot seed yield.

At harvest, both Othello and Fargo produced significantly taller (10 cm) plants compared to CDC Pintium. Regardless of the size of seeds planted, on average, CDC Pintium flowered five days earlier than both Othello and Fargo, but there was no cultivar difference in terms of crop maturity (all cultivars matured about 98 days after seeding). On average, CDC Pintium produced the heaviest seed and Fargo produced the lightest seed among the three cultivars. The size of seed planted had no significant impact on the final plant height, number of seeds per plant, seed yield per plant, plot seed yield or seed size profile of the resulting bean crop. However, the seed size profile was significantly different among cultivars. On average, CDC Pintium, Othello and Fargo produced seed lots with 75.7, 59.9 and 45.9 per cent in the >7.9 mm in diameter category, respectively. Production of a higher portion of larger seeds by CDC Pintium appears to be partially associated with its longer flowering period.

Effect of flowering habit, stem cutting length and rooting hormone on plant growth and medicinal quality of St. John's Wort

A greenhouse study was conducted to examine the effect of flowering habit on the medicinal quality of St John's Wort, using field grown stem cuttings of three cultivars, Anthos, Elixir and Topas. Single plants from three groups with varying flowering habits (early, middle and late) within each cultivar, were selected for stem cuttings. Plant growth and rooting ability of single and double nodal stem cuttings were evaluated with or without rooting hormones (3-Indolebutyric acid). Results indicated that flowering habit had a cultivar-specific significant impact on medicinal quality. Double nodal stem cuttings were superior to single nodal cuttings in respect to plant growth and the hormone treatment had no impact on rooting of the cutting. Plant selection based on flowering and medicinal quality, is in progress.

Intercropping studies

A study was established to evaluate the interaction effects of several field crops, field peas, feed barley, fababeans and silage corn and spice crops, coriander and fenugreek on growth and development of these species, when grown as intercrops under field conditions at CDCS. Results indicated that when seeded at 50 per cent seeding rate fababean, fenugreek and field peas can be grown successfully as intercrops with feed barley and silage corn to improve feed quality. Coriander was not suitable as an intercrop since it is a poor competitor with other crops, particularly feed barley.

Crop selection and improvement

Seed of *Echinacea angustifolia, E. pallida, E. purpurea* and borage, and stolons of peppermint, spearmint and Alaskan mint were treated with mutagenic compound, Ethyl Methanesulphonate (EMS). Treated seeds and stolons were planted in plugs or pots and placed in a greenhouse. In early spring, both *Echinacea* and mint species were transplanted in CDCS plots. *Echinacea* species are being evaluated for aster yellows disease resistance and medicinal quality. Mint species are being evaluated for over wintering ability and essential oil contents. Foliage of individual mint plants raised from the treated stolons was used to extract the essential oil. Crop selection, based on essential oil content, oil composition and over-wintering ability is in progress.

The seed harvested from EMS-treated seed borage plants was planted in spring 2001 in the field for selection and seed multiplication. Based on maturity, borage plants were categorized into several groups and further selection is in progress based on seed shattering and seed oil content and quality.

Evaluation and selection of different lines/selections of essential oil, spice and health promoting crops are conducted for adaptability under the growing conditions in southern Alberta and to develop management practices for improved and sustainable production. Plant species included in this evaluation are coriander, dill, rosemary, lavender and mint.

Technology Transfer Services

Program staff continued to answer numerous inquiries on the production of special crops, particularly on herb, spice and essential oil crops. Information was contributed on special crops to producer newsletters and the news media. The special crop variety performance factsheet was updated. Program staff participated in courses (Olds College), seminars, conferences and field tours. Demonstration plots of various special crops, including herbs, spices, essential oil, medicinal plants and other new crops at Brooks and Bow Island were visited by a large number of interested individuals, groups and college students.

The Alberta Regional Special Crops Variety Test was coordinated, prepared and distributed. The performance data of registered varieties of fieldpeas, dry beans, lentils and fababeans was summarized and made available to cooperators, specialists, growers and agribusinesses.

Special Crops Program (Beaverlodge)

R. El Hafid, L. Ost and J. Thibodeau

Recognizing the lack of a special crops research initiative serving the Peace region, AAFRD proceeded with the recruitment of a research scientist in July 2000. The entire initiative is identified as the Crop Diversification Centre Peace (CDCP) is located at the AAFC-Beaverlodge Research Farm to complement and collaborate with the special crops research programs at CDCN and CDCS. This new initiative is indicative of the collaboration and partnership between AAFC and AAFRD to ensure that the Peace region has a strong research framework to develop new technologies for the entire zone.

The mandate of this program is to promote crop diversification and new crop development, mainly in northern Alberta, with the ultimate objective of fostering economic viability and sustainability of the special crops industry in the Peace River Region.

This was an exciting and productive year at CDCP as several research/extension projects were initiated in collaboration with scientists and specialists from AAFRD, AAFC, and academia. The program now has a permanent technician who has been of a tremendous help. Some equipment have been either purchased or transferred from CDCN and CDCS allowing the program staff of CDCP to be more flexible and independent in carrying out the research activities.

Research Projects

Fall seeding studies

In collaboration with Drs. S. Blade (CDCN) and M. Bandara (CDCS), field experiments were established in October 2000 at three different locations in the province (CDCN, CDCS, and CDCP) to examine the practicality of fall seeding anise, dill, coriander, chickpea and peas and yellow mustard. Preliminary results from the Beaverlodge site showed that fall seeding (mid-October) was (i) successful for coriander and dill, (ii) successful to a certain degree for chickpea and (iii) not successful for mustard, lentil and anise. Seed coating did not improve stand establishment or yield of most of the fall-seeded crops. For most species, increasing seeding rate to four times the recommended rate did not result in any significant increase in yield as compared to two times recommended seeding rate.

Adaptation and agronomics of new oilseed crops for non-food industrial uses

The overall purpose of this research is to examine the viability of developing novel oilseed crops that produce specific fatty acids required by non-food industries. Two field experiments (Beaverlodge and Fairview) were established to (i) determine the adaptability of five crops (*Camelina sativa* L., *Crambe abyssinicia* Hochst, *Cuphea* sp., *Limnanthes alba* Benth and *Lunaria annua* L.) and (ii) develop agronomic practices for optimizing their seed yield and quality. In terms of adaptability, *camelina*, *crambe* and *lunaria* can be grown successfully in the Peace River region. *Cuphea* didn't emerge from the soil, probably due to a seed germination problem as evidenced by germination test performed in the laboratory. Although meadowfoam (*Limnathes alba*) could be grown in the Peace, the major handicap is that most of the seed produced is too close to the ground making it almost impossible to harvest.

Optimum seeding rate should target an average stand of 100 plants/m^2 for crambe and 300 plants/m^2 for camelina.

Since there is no registered herbicide for use in these new crops, increasing the seeding rate has shown to be effective in reducing weed biomass. However, for most of the species, increasing seeding rate up to three times the recommended rate was not enough to obtain the seed yield obtained in plots seeded at recommended seeding rate and maintained under weed-free conditions.

Crambe and *camelina* are easy to grow in the Peace Region. *Lunaria* is a biannual and may not fit in the cropping systems of many farmers. *Cuphea* and meadowfoam are not recommended for cultivation in the Peace Region.

New millennium silage trial

The overall purpose of this multi-location study is to optimize silage yield and quality of cereal-pea mixtures through improved management practices such as seeding rate and cultivars. Six locations, including Beaverlodge, were seeded to compare various seeding rates of barley and triticale with Swing and Performance 4010 field pea as sole crops or as intercrop mixtures.

This research is conducted in cooperation with many scientists and crop specialists of AAFRD. The project leaders (Dr. Stan Blade and K. Lopetinsky) will report the results.

Non-traditional high quality forage crops with distinct advantages for livestock production

The overall purpose of this multi-location study is to develop, evaluate, and introduce the first forage cultivar of fenugreek adapted to Alberta growing conditions and associated cultural practices for optimizing forage and seed production. Eight fenugreek cultivars were compared in terms of forage and seed production to Performance pea 4010 and berseem clover. First-year preliminary results from the Beaverlodge site showed the fenugreek cultivars Amber, F80 and F86 are the most promising ones in terms of forage and seed production. Performance pea 4010 out yielded all fenugreek cultivars.

Field pea breeding lines evaluation

Two independent trials to evaluate germplasm developed by the pea breeding programs at CDCN and the University of Saskatchewan were carried out at several locations, including CDCP-Beaverlodge. Fifty-seven entries were evaluated. Please refer to the CDCN Special Crops Program section for more details.

Field pea regional variety trial

Sixteen yellow and 17 green field pea varieties were evaluated in several locations in the province, including CDCP-Beaverlodge. Please refer to the CDCS Special Crops Program section for more details.

Technology Transfer Services

The program leader, R. El Hafid received and answered numerous inquires about a wide range of new crops production issues. Producers were provided written materials on many aspects related to the agronomics of special crops. More than 300 people visited the research plots at Beaverlodge and Fairview through field days and tours. He attended many producers meeting (pulse growers, organic farmers, etc.) where he answered several inquiries and presented the CDCP research activities. Presentations were given to farmers, scientists and extension specialists.

R. El Hafid wrote five sections for the hemp CD, an AAFRD initiative, to be released shortly. The five sections included hemp botany and biology, hemp history, hemp global status, hemp uses and medicinal cannabis. He also co-authored a manual on *Special Crops for the Peace*. More than 200 copies of this manual have been distributed to interested parties.

R. El Hafid presented two posters on borage agronomy at the Agronomy Conference 2002 at Nisku and the FarmTech 2002 at Red Deer. He also prepared a presentation on borage agronomy for the international conference on new crops and new uses held in Atlanta, USA. Dr. Stan Blade gave the presentation on his behalf.

Weed Science Program

C. Neeser and B. Kruger

The objective of the weed science research program at CDCS is to develop optimal weed management strategies that will contribute to increased crop diversification in Alberta. Activities of the program emphasise applied research, but also include a significant extension component.

Research Projects

Research projects conducted in 2001 were categorized as follows: 1) minor use registration and label extension, 2) alternative technologies, 3) decision support systems, and 4) special problems. Minor use registration and label extension refers to work that is intended to assist with registration and label extension of herbicides that can be used on crops that occupy a smaller proportion of the cultivated land in Alberta. Alternative technology includes projects that are aimed at the development of new weed management tools. Research projects in the decision support category are intended to provide data needed for the development of state of the art weed management software. Finally, projects that address specific weeds are grouped under special problems.

Herbicide minor use registration and label extension

Potato Recropping

Potatoes are sensitive to a variety of commonly used persistent herbicides. In order to make optimal herbicide use and planting decisions, growers need reliable information regarding herbicide persistence and how it may affect potatoes.

Several relatively new herbicides which are commonly used on fields that may include potatoes in their rotation were identified. The objective was to assess the effects of standard rates of these products, Sundance®, Ally®, Assert® 300, Muster®, and Prestige®, on Russet Burbank and Shepody potatoes, one and two years after application. In 2001 the herbicides were applied to wheat, Sundance®, Ally®, Assert® 300, and Prestige® and canola, Muster®, using recommended rates. Plots were irrigated to insure optimal crop growth. The treated plots will be planted with potatoes in the spring of 2002. Phytotoxicity will be assessed visually and in terms of tuber yield, quality, storage weight loss and frying color. Results will be made available to growers in a suitable format.

Volunteer Herbs & Spices

Many herb and spice crops exhibit considerable seed shattering, which may lead to weedy volunteer crops. Currently there is very little information available on herbicide efficacy on such volunteer crops. Therefore, a screening trial was set up to identify herbicides suitable for this purpose.

Borage (*Borago officinalis*), dill (*Anethum graveolens*), caraway (*Carum carvi*), coriander (*Coriandrum sativum*), and catnip (*Nepeta cataria*) were chosen as the test volunteer crops and 2,4-D amine, Attain®, Banvel®, Lontrel™, Pursuit®, Odyssey®, Refine Extra®, Sencor®, and Edge™ as the herbicide treatments. The herbicides were applied following label recommendations. Caraway and coriander were most effectively controlled with Lontrel™ and Sencor®. Control of borage was best with Refine Extra® and control of dill was best with Sencor®.

Cut Flowers

Field grown cut flowers can fill a relatively lucrative niche market for small producers. Chemical weed control options in field grown cut flowers are nearly nonexistent. Therefore, a field screening trial was conducted to select potential pre and postemergence herbicides. Basagran®, Devrinol®, Edge™, Eptam®, Lontrel™, Lorox®, Pursuit®, and Treflan™ were tested on aster, bachelor buttons, larkspur, statice, and stocks.

The most useful herbicides for the assortment of flowers tested appeared to be Edge, Lorox, and Treflan. Bachelor buttons had good tolerance to all three products, asters had excellent tolerance to Edge and Treflan, statice tolerated Lorox, and stocks exhibited very good tolerance to Edge.

Everest®

Everest® is a new herbicide for grass control in cereals. Experience has shown that current label information pertaining to recropping restrictions may not be entirely adequate, especially in the brown and dark-brown soil zones.

In order to address issues regarding crop rotations under irrigation the following study was initiated. Amber® and Everest® were applied to plots of irrigated and non-irrigated wheat. Amber® was applied at the rate of 11 g active ingredient per acre and Everest® was applied at the rate of 15, 30, and 60 g of active ingredient per acre. In the spring of 2002 areas treated with Everest® will be planted to oats, lentils, chickpea, sugar beet, and potato. Herbicide injury will be assessed visually and in terms of crop yield.

Alternative technology

Development of alternative weed management technologies can be essential for the production of many specialty crops. During 2001 three new projects in the area of alternative weed management were initiated.

Thermal weed control

Hot steam has been used successfully in Europe for weed control in vineyards. Unlike the commercially available infrared weed control devices, a steam generating system presents no significant fire hazard. Furthermore steam can be projected far enough to keep a save distance between the delivery nozzle and the soil surface. A significant drawback of infrared burners is their requirement to operate close to the soil surface, which can lead to poor results when stones or other debris are present.

The project was designed to examine whether hot steam could be used to selectively control weeds. Several species of weed seedlings at different growth stages were exposed to hot steam (92°C) for varying time intervals. Preliminary results suggest that steam could indeed be used to selectively remove weeds from crops that are at a sufficiently advanced growth stage.

Compost

Composted feedlot manure is promoted as a cost-effective soil amendment to improve soil structure and fertility. Increased organic matter can lead to reduced activity of a variety of herbicides. Compost was tested to determine if it would be useful in reducing the phytotoxicity of persistent herbicides. Herbicides were chosen that have significant recropping restrictions, Amber®, Bladex®, Everest®, Lontrel®, Poast Ultra®, Sencor®, and Sundance® and they were applied to soil collected in the field at 10% of the normal rate.

The treated soil was amended with four levels of compost. Sensitive plants were grown for three weeks in pots containing treated soil; the fresh weight was measured for each plant. Results indicated that compost did not significantly reduce herbicide damage. Therefore, compost rates typically applied to commercial fields cannot be expected to reduce phytotoxicity of the herbicides tested.

Wheat gluten

Corn gluten has clearly demonstrated herbicidal properties against several common grass and broadleaf weeds. Research reports indicate similar properties for wheat gluten.

In order to further assess the potential herbicidal use of wheat gluten preliminary experiments were conducted. Unfortunately, technical problems were encountered which have not been yet solved.

Decision support systems

Decision support software can help growers to make better and quicker weed management decisions, which can result in substantial economic benefits. At this time the development of advanced decision support software for weed management is hampered by the lack of basic data on weed-crop biology. The following projects were designed to address some of the most critical knowledge gaps.

Competitive index

Yield loss due to weed competition is primarily a function of weed species, crop species, and environmental conditions. If these factors are well defined it is generally possible to accurately predict yield losses due to weeds. If the negative impact of a particular weed species is known, weed management strategies can be designed to achieve the most cost-effective control. Weed control targeted at the most competitive species is expected to require a reduced control effort (as opposed to maximum control of all existing species), and therefore a lower amount of herbicide. Benefits of lower herbicide application rates include: 1) educed risk of environmental contamination, 2) reduced input costs, 3) reater economic efficiency, and 4) less product carryover.

A study was conducted to measure yield loss in peas and beans caused by competing kochia (*Kochia scoparia*). Results clearly show that kochia is an extremely competitive weed. The data collected will serve as a reference point for the ranking of other weeds.

Weed seedbank

In the absence of new seed input, the number of weed seeds in the soil declines over time as a result of various mortality factors. Knowledge of the rate of decline of weed seeds present in the soil has direct implications in designing crop rotations optimized for weed management.

This year a study continued that was initiated in the fall of 2000. The study was designed to estimate rates of seed mortality from counts of emerging seedlings. Treatments consisted of different tillage systems (conventional tillage, reduced tillage, and zero-till). Results after one year clearly show a rapid decline in the number of seedlings emerging. However, in order to obtain a realistic picture of the changes in the seedbank, measurements must be collected for at least another three to four years.

Density dependent herbicide efficacy

Recent research from Nebraska and elsewhere has shown that weed density can substantially reduce herbicide efficacy. However, it was not clear whether this is likely to be a significant phenomena with weed densities commonly encountered under field conditions.

Two field experiments were designed to test whether the existence of a negative relationship between herbicide efficacy and weed density can be shown conclusively under field conditions. Both experiments were conducted with Basagran, which was applied to a natural population of a variety of broadleaf weeds. Results did not show the herbicide efficacy declined, even at the highest densities, which were far in excess of 500 plants per square metre.

Special problems

New weed problems can arise through the expansion or introduction of species not currently found in Alberta. More likely, however, is the emergence of new weed problems through selection of adapted biotypes; this is commonly seen in the development of herbicide resistant populations. If a new weed problem is identified it is generally advisable to implement measures that will limit further spread.

Water smartweed

In 2000 and early 2001 specimens of an unidentified prostrate rhizomatous weed were provided by a local agrologist. This weed was of concern as it seemed to be spreading. Attempts to control it with high doses of Roundup and several other herbicides had not been successful.

Cuttings were grown in the greenhouse and sufficient material was obtained to conduct a herbicide screening trial. Among the nine herbicides tested the best results were achieved with Banvel®, Lontrel™, and Ally®. During 2001 field season cuttings were established in the field under irrigated conditions. These specimens produced flowers in early fall, which allowed for the positive identification of water smartweed (*Polygonum amphibium var. emersum*). Field performance of Banvel®, Lontrel™, and Ally® will be tested in the spring of 2002.

Technology Transfer Services

Weed control recommendations were provided to growers by telephone, letter or office/farm visits, and presentations were made at producer and professional meetings. The weed science program continued to receive a significant number of enquiries concerning safe recropping intervals following the use of persistent herbicides for potato and vegetable crops.

Pest Prevention and Management Unit

Dutch Elm Disease Prevention and Arbor Day Program

J. Feddes-Calpas and B. Lee

Dutch elm disease prevention program

Alberta is constantly aware of the threat of Dutch Elm Disease (DED) which presses the Province's borders from two sides, Saskatchewan and Montana. AAFRD with cooperation of the Society to Prevent Dutch Elm Disease (STOPDED) has focused on the prevention of this deadly disease.

Alberta's DED Prevention Program consists of several components:

- monitoring for the smaller European elm bark beetle (SEEBB) and the native elm bark beetle (NEBB), vectors of the disease
- surveillance for the disease
- pruning of dead wood out of elms
- firewood confiscation at the Alberta-Montana ports of entry
- public awareness and education.

A provincial hot line number is in place to answer all calls concerning elms.

Monitoring for the vectors is accomplished by using sticky panel traps and pheromone lures. In 2001, traps were placed in 477 sites throughout the province in municipalities, provincial and municipal parks, nurseries and at all the Alberta-Montana ports of entry. As a result of the monitoring, SEEBB's have been found in the past number of years in Edmonton, Strathcona County, St. Albert, Calgary, Medicine Hat, Red Deer, High River, outside Balzac, Killam, Lloydminster, Coutts, and Vauxhall. Three beetles were found on traps in Edmonton, 32 in Calgary, one in Lloydminster, two in Lethbridge, two in Taber, one in Coutts. A new record of 17 beetles on one trap were found in Wetaskiwin. No NEBB's were found. Additional surveillance for DED symptoms in locations where beetles were found was done through the summer months.

A total of 68 samples from wilting elms were submitted to the University of Alberta's Plant Pathology Lab and cultured. All results were negative for the presence of DED. The City of Edmonton submitted 43 of these samples to the lab of which 38 were identified as *Dothiorella ulmi*. This brings the total cases of Dothiorella wilt in Edmonton since 1996 to 180. In 2001, 29 of the 38 infected trees were removed. There has been 74 Dothiorella wilt-infected American elm removed in Edmonton since 1996. The profile of confirmed Dothiorella wilt cases in Edmonton's elm population is strongly associated with larger, (mean dbh of 42 cm), roadway (96.5% of cases) American elm trees concentrated in the inner densely elm-planted areas of the city.

To date, only one case of DED has been reported in Alberta. In 1998, a single elm tree in Wainwright was tested positive for DED, removed and burned.

Due to the increased concern in Alberta, STOPDED has committed funding toward *D. ulmi* research, conducted by Dr. J.P. Tewari of the University of Alberta and Chris Saunders with the City of Edmonton. This research involves using Engage Agro's systemic fungicide, Alamo, recently registered against the DED fungus, to see how it works against the Dothiorella fungus. Applications have been made to ten infected American elms in late July. Some trouble with the uptake of the product was experienced and some phytotoxicity was observed. This was likely due to the treatment doses based

on dbh and often-considerable canopy volume had been removed due to disease dieback. Wilt symptoms appear to be less in treated trees but were also not visible in an untreated control tree with the disease. Given funding availability, the study will continue with further applications and observations in 2002.

A DED Educational Resource kit was completed and sent out to 1500 schools in AB. This kit includes a Teacher's Guide, a before and after illustrated DED poster and the STOPDED fifteen minute educational video. The resource guide provides teachers ready-made activities that can be used to teach an assortment of requirements of the grade four and six curriculum. Dr. Elmwood and his dog Bark, mascots of the program, explain what DED is and how it can be prevented using these activities.

DED Public Awareness Week was recognized throughout the province during the week of May 28 to June 1 using radio announcements and articles in local papers. Displays were set up in a number of municipalities. Due to the increased amounts of firewood confiscated, several new larger bins were placed at the Alberta-Montana borders.

Severe drought conditions, especially in the south and eastern portions of the province, have caused significant damage to the American elm. Red elm weevil continues to cause additional damage to the trees, mainly in Lethbridge, although more areas are reporting damage. Calgary has reported their first incident of red elm weevil this year. Hard-shell scale on elm has also been reported as a concern. The City of Calgary is planning to initiate a dormant oil spray this coming spring. Some cases of leaf miner damage on Siberian elm is also seen throughout the province.

For further information, visit the Alberta DED Prevention Program and STOPDED website at <www.agric.gov. ab.ca/ded>.

Arbor day program

Arbor Day, a provincial annual event, was celebrated on May 3, 2001. To help grade one students realize the importance and beautification value of trees, and to commemorate their first year in school, they were presented with a tree seedling to plant. Students in grade one and some grade threes received 60,000 spruce and lodgepole tree seedlings. Many communities had special events involving the whole community scheduled.

AAFRD had historically supplied the Arbor Day tree seedlings since 1959. In 2001, for the first time, a memorandum of understanding was signed between AAFRD and Environment Protection (EP) in regards to Arbor Day. EP supplied the Arbor Day trees and AAFRD was responsible for the coordination of the program and distribution of the trees. In the past, trees were handed out in some municipalities to grade one students and in other municipalities to grade three. To make the program more consistent across the province, tree seedlings will be supplied to grade one students. A teacher's resource guide titled *Helping Grade One Students Celebrate Arbor Day* was developed by AAFRD and EP to help ensure tree survival. Through a number of fun activities, students will learn to properly care for their seedlings while covering objectives from the grade one science unit, "Needs of Animals and Plants."

Arbor Day will be celebrated on May 2, 2002.

Meteorological Report

N.G. Seymour and T.T. Pheh

The Alberta Agriculture, Food and Rural Development's CDCS operates two automated weather stations; one at the Centre southeast of Brooks and another at the sub-station southwest of Bow Island.

Brooks (CDCS) — Precipitation is measured with two instruments at the Brooks station. The Tipping Bucket Rain Gauge (TBRG) very accurate in reading rainfall to 0.2 mm is not reliable for recording snowfall. The Fischer-Porter Weighing Gauge (F&P) provides an accurate reading for snowfall equivalent. During the growing season of 2001, Brooks received very little average rainfall while temperatures were near or above the 30-year averages. Total precipitation for the year was only 36 per cent of the 30-year average for Brooks. In 2000, the total rainfall was only 42 per cent of the 30-year average. Two very dry years back to back.

The final spring frost of 2001 occurred on May 21(-0.2°C). The first autumn frost was -0.2°C on October 2, giving a total of 135 frost-free days in 2001. This is higher than the 30-year average (1951-80) of 116 frost-free days (May 21 to September 15).

Table 1. 2001 Brooks (CDCS) Weather Data

	Temperatures (°C)							
	Extremes		Average				Means	
	Max	Min	Max	30 yr av	Min	30 yr av	2001	30 yr av
January	10.5	-19.4	3.1	-6.9	-10.5	-23.6	-3.7	-12.5
February	10.6	-29.6	-6.1	-2.4	-20.7	-13.9	-13.4	-8.2
March	15.2	-13.3	8.0	3.1	-5.6	-10.6	1.2	-2.7
April	27.5	-10.5	13.2	12.2	-2.3	0.7	5.5	5.1
May	33.6	-4.0	21.3	18.7	4.8	3.5	13.1	11.4
June	31.5	2.4	22.6	23.0	8.3	9.8	15.5	15.9
July	35.5	8.0	27.8	25.9	11.9	11.8	19..8	18.3
August	37.2	5.3	29.8	25.2	10.2	10.9	20.0	17.5
September	32.6	0.2	22.8	18.9	5.7	5.8	14.2	11.6
October	23.3	-11.9	13.0	13.6	-2.6	-1.4	5.2	6.3
November	19.2	-20.7	7.5	2.1	-4.3	-13.3	1.6	-3.7
December	6.1	-25.7	-3.8	-4.6	-15.5	-21.3	-9.7	-10.3
Average	23.6	-9.9	13.3	10.7	-1.7	-2.6	5.8	4.1

	Precipitation (mm)			
	2001			1961-90
	TBRG		F&P	30 yr av
January		n/a	4.2	18.4
February		n/a	2.8	11.9
March		n/a	4.2	17.0
April		5.0	5.0	26.9
May		9.4	8.1	39.1
June		43.6	40.9	65.4
July		13.8	13.4	38.0
August		1.4	2.7	36.3
September		16.6	17.3	38.8
October		8.4	6.5	15.8
November		n/a	13.0	14.9
December		n/a	3.5	18.4
Average	Tot.	n/a	121.6	341

Bow Island (Sub-station) — The last recorded frost was -4.3°C on May 7 and the first autumn frost (-1.4°C) occurred on October 2, for a total of 149 frost-free days in 2001, greater than the 30-year average (1951-80) growing season at Bow Island of 125 days (May 17 to September 20).

The precipitation recorded during the summer months indicates another very dry growing season in Bow Island. It is important to note that precipitation is only measured with a tipping Bucket Rain Gage which is unreliable during the winter months.

Table 2. 2001 Bow Island Weather Data

	Temperatures (°C)							
	Extremes		Average				Means	
	Max	Min	Max	30 yr av	Min	30 yr av	2001	30 yr av
January	10.6	-19.9	1.9	-5.2	-10.1	-15.9	-4.0	-10.6
February	8.4	-29.4	-6.1	-0.9	-18.6	-11.7	-12.3	-6.3
March	16.0	-12.7	7.7	4.7	-4.3	-6.6	1.7	-0.9
April	26.7	-8.3	12.3	12.5	-0.5	0.2	5.9	6.6
May	33.2	-4.3	21.6	19.2	5.6	5.5	13.6	12.4
June	31.1	3.0	22.3	24.4	8.3	10.7	15.3	17.6
July	36.2	5.9	28.1	27.6	11.0	12.1	19.5	19.7
August	36.7	4.6	29.4	27.1	10.6	11.9	20.0	19.6
September*	33.3	0.0	22.5	20.2	6.7	5.6	14.6	12.9
October	23.2	-8.6	13.3	15.0	-1.4	0.5	6.0	7.6
November	20.3	-21.8	8.7	4.7	-3.8	-6.6	2.5	-1.0
December	6.2	-25.4	-1.6	-2.8	-13.6	-13.0	-7.4	-7.9
Average	23.5	-9.7	13.3	12.2	-0.8	-0.6	6.2	5.8

* Data for September may be inaccurate because the station was not functioning from September 4-6.

	Precipitation (mm)		
	2001		1961-90
		TBRG	30 yr av
January		4.1	18.6
February		1.0	11.3
March		5.6	13.1
April		14.2	34.2
May		12.2	44.9
June		35.6	69.8
July		7.9	30.9
August		0.5	32.4
September*		2.0	30.4
October		4.8	12.3
November		4.1	12.8
December		1.0	19.0
Average	Tot.	93.0	330

* Data for September may be inaccurate because the station was not functioning from September 4-6.

Edmonton (CDCN)

Table 3. 2001 Edmonton (CDCN) Weather Data

	Temperatures °C					
	Extremes		Average		Means	
	Max	Min	Max	Min	2001	30 yrs
January	7.24	-19.06	2.07	-9.8	-3.87	-10.1
February	-31.05	13.32	-5.33	-19.15	-12.24	-9.8
March	12.65	-20.68	5.36	-8.04	-1.34	-3.3
April	26.43	-12.9	12.4	-3.08	4.66	5
May	28.04	-1.03	18.88	3.66	11.27	11.05
June	27.21	4.46	19.2	8.12	13.66	14.75
July	32.88	7.07	22.85	10.88	16.87	16
August	30.49	4.31	24.85	9.56	17.21	15.4
September	*	*	*	*	*	11
October	*	*	*	*	*	4.5
November	*	*	*	*	*	-5.3
December	*	*	*	*	*	-10.1
Averages						3.26

* no record—data logger not functioning.

	Precipitation			
	Snow (cm)		Rain (mm)	
	2001	Average	2001	Average
January	*	20.3		2.6
February	*	16.5		3.5
March		12.9	1.9	2.2
April		11.7	1.2	12.4
May		10.9	38.3	46.8
June		0	46.5	91.4
July		0	136.2	91.6
August		4	23.6	73.3
September		2.5	34.8	42.6
October	11.6	6.5		11.5
November	20	13.5		3.7
December	6.8	21.4		2.7
Total		120.2	282.5	384.3

*no record taken

Heat Units* at CDCN calculated from last to first killing frost.**

April	2.76
May	156.25
June	259.87
July	367.83
August	378.43
September	196.63
October	11.82
Total	1373.59

Last killing frost — April 23, 2001
First killing frost — October 5, 2001
Number of frost free days = 164

* Calculation based on 5°C base temperature.
** Killing frost is taken as minus 2°C.

Publications and Presentations

Research Reports

Bains, P.S. and C. Schaupmeyer. 2001. Rhizoctonia disease of potato (*Rhizoctonia solani*): fungicidal control, cultivar susceptibility and effect of rotation crops. Final report project #97M077, AARI. 36 pp.

Bandara, M. and E. Russell. 2001. Cultivar evaluation and agronomic practices of caraway in Alberta. Final report project #97M087, AARI. 21 pp.

Bandara, M. and E. Russell. 2001. Evaluation of mint types and other essential oil crops in Alberta. Final report project #97M086, AARI. 36 pp.

Baron, V.S. and H.G. Najda. 2001. Feasibility of extending the grazing and growing season with short-season corn. Final report submitted to Pioneer Hi-Bred Limited. AAFC. 46 pp.

Bing, D.J., T. Warkentin, S.F. Blade and R. Conner. 2001. Interrelationship of factors influencing field pea (*Pisum sativa* L.) in western Canada. Proceedings of the North American Pulse Improvement Association Biennial Meeting. Fargo, ND.

Blade, S.F. 2001. Identification of superior field pea lines for Alberta. Project #E121, AARI. 18 pp.

Blade, S.F., T. Buss, P. Laflamme and K. Lopetinsky. 2001. Grain and silage yield of field pea/cereal cropping combinations. The Fourth European Conference on Grain Legumes Proceedings. Part II: 348-349. Cracow, Poland.

Chang, K.F., R.J. Howard, W. Van Roessel and L. Andersen. 2001. Demonstration of chemical control and cultivar resistance for reducing halo blight of dry bean. Final report project #98SR03, AARI. Edmonton, AB. 53 pp.

Chang, K.F., S.F. Hwang, D.A. Burke, R.J. Howard and M. Bandara. 2001. Study of etiology and management mint stolon rot in Alberta. Progress Report to the Alberta Horticultural Congress and Foundation Society, 19 pp.

Hausher, L.G. and S. Dalpe. 2001. Fruit Crop Trials. CDCS Pamphlet 2002-6.

Hwang, S.F., G.D. Turnbull, K.F. Chang, R.J. Howard, R. Bjorklund, T. Buss, K. Piquette and K. Lopetinsky. 2001. Practical strategies for controlling Ascochyta (Mycosphaerella) blight on field pea. Final report project #98M263, AARI. Edmonton, AB. 81 pp.

Hwang, S.F., G.D. Turnbull, K.F. Chang, R.J. Howard and H. Yoder. 2001. Alfalfa stand establishment and sustainability in a direct seeding system. Final report project #97-AB085, Canada-Alberta Beef Industry Development Fund Research Program. 54 pp.

Hwang S.F., K. Lopetinsky, T. Kloeck and G. Turnbull. 2001. Effects of seeding date and chemical seed treatments on rhizoctonia blight of field pea. FFF Project #01-NW-02.

Johns, O., C. Murray, H. Childs, J. Quereshi, J. Wang and J. Hill. 2001. Perennial trial garden 1999-2001. AARI On-Farm Demonstration Program 99CR10.

Lopetinsky, K. and S.F. Blade et al. 2001. Evaluation of special purpose field pea cultivars. FFF Project #99-NW-01.

Lopetinsky K., S.F. Blade and S.F. Hwang et al. 2001. Field evaluation of assochyta blight control with Bravo® on field pea. Final report, FFF Project #99-NW-03.

Lopetinsky K., I. Evans and S.F. Blade et al. 2001. Evaluation of soil and foliar micronutirents on field pea yield. Final report, FFF Project #99-NW-02.

Lopetinsky K., N. Harker and S.F. Blade et al. 2001. Evaluation of two gramminicide application dates for field pea yield and grassy weed control. Final report, FFF Project #99-NW-04.

Lopetinsky K. and S.F. Blade et al. 2001. Evaluation of new field pea varieties in NW Alberta. Final report, FFF Project #98-NW-03.

Lopetinsky K. and L. Dosdall. 2001. Lygus bug control in fababean crops in northwest Alberta. FFF Project #01-NW-06.

Murray, C.L., T.T. Pheh and N.G. Seymour. 2001. Nursery crops program, 2000. CDCS Pamphlet 2001-8, 24 pp.

Murray, C.L. and R.C. McKenzie. 2001. Investigation of the growth of two species of field-grown trees at different nitrogen fertilizer rates – CDCN and CDCS. AARI Project # 97M085 & 329085.

Murray, C.L., T.T. Pheh and N.G. Seymour. 2001. Regional woody plant test project 2000. CDCS Pamphlet 2001-3. 53 pp.

Najda, H.G. and A. Kruger. 2001. Grass seed and forage crops program. Annual Report 2000. CDCS 00-9. AAFRD. 85 pp.

Najda, H.G., A. Kruger and A. Aasen. 2001. Alberta regional forage variety testing program. Annual Report. 37 pp.

Najda, H.G., A. Kruger and A. Aasen. 2001. Western forage variety testing program. Annual Report. 163 pp.

Najda, H.G. and A. Kruger. 2001. Western Canadian Grass Seed Testing Program. Annual Report. 47 pp.

Nleya, T., Y. T. Gan, A. Vandenberg, R. Kutcher, M. Bandara, F. Holm and E. Johnson. 2001. Lentil for the next century: diversification of red lentil production systems. Progress report No. 4, project # 99000088. Res: 78BW. USASK 7-00317. 8 pp.

Pruski, K., B. Choban and K. Ampong-Nyarko. 2001. Integrated Pest Management Approach for Control of Root Maggot, *Delia radicum* (L) in Cabbage Crops in Alberta. Final report, project #98M220. AARI. Edmonton, AB. 44 pp.

Slinkard, A.E., R. Wilen, B. Barl and M. Bandara. 2001. Evaluation of calendula as industrial oil-seed crop. Final report project 98000314-Res 65 BW (7- 74210), ADF. 20 pp.

Warkentin, T., S.F. Blade, D.J. Bing, A. Vandenberg, M. Jordan and G. Penner. 2001. QTL analysis of lodging resistance in field pea. The Fourth European Conference on Grain Legumes Proceedings. Part 2: 164-165. Cracow, Poland.

Warkentin, T., M. Bandara, B. Vandenberg and C. Weisbach. 2001. Lentil and chickpea cultivar development for Alberta 2001. Progress report No.1, project #2001J381. 12 pp.

In 2001 Pest Management Research Report—Insects and Plant Diseases. Expert Committee on Integrated Pest Management, Agriculture and Agri-Food Canada, ON. January, 2002.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of Apron Maxx to control fusarium root rot of lentil in Alberta in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of fungicidal seed treatments to control rhizoctonia root rot of field pea in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of fungicidal seed treatments to control rhizoctonia root rot of soybean in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of fungicidal seed treatments to control rhizoctonia root rot of dry bean in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of fungicidal seed treatments for the control of fusarium root rot of dry bean in Alberta in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Efficacy of foliar fungicide formulations against ascochyta blight of chickpea in Alberta in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of fungicidal seed treatments for the control of rhizoctonia seedling blight and root rot of chickpea in Alberta in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Efficacy of foliar fungicide formulations against ascochyta blight of chickpea in Alberta in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2001. Evaluation of fungicidal seed treatments for the control of pythium root rot of dry bean in Alberta in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang, G.D. Turnbull and H. Wang. 2001. Evaluation of fungicidal seed treatments to control rhizoctonia seedling blight and root rot of chickpea in 2001.

Chang, K.F., R.J. Howard, S.F. Hwang, G.D. Turnbull and H. Wang. 2001. Evaluation of fungicidal seed treatments to control seedling blight of chickpea caused by botrytis in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Evaluation of fungicidal seed treatments to control rhizoctonia root rot of lentil in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Evaluation of fungicidal seed treatments for the control of rhizoctonia root rot of lentil in Alberta in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Evaluation of fungicidal seed treatments to control botrytis seedling blight of lentil in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Evaluation of foliar spray treatments for the control of mycosphaerella blight of field pea in Alberta in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Assessment of fungicidal seed treatments to control rhizoctonia root rot of field pea in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Efficacy of foliar spray formulations against anthracnose of dry bean in Alberta in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Evaluation of fungicidal seed treatments to control anthracnose of dry bean in 2001.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Evaluation of fungicidal seed treatments to control anthracnose of dry bean in 2001.

Su, H., S.F. Hwang, S.F. Blade, G.D. Turnbull, K.F. Chang, R.J. Howard, R. Bjorklund, T. Buss and K. Piquette. 2001. Screening of pea germplasm, lines and cultivars for resistance to powdery mildew and ascochyta blight.

Turnbull, G.D., S.F. Hwang, S.F. Blade, K.F. Chang and R.J. Howard. 2001. Evaluation of foliar spray treatments for the control of powdery mildew of field pea in Alberta in 2001.

Turnbull, G.D., S.F. Hwang, K.F. Chang and R.J. Howard. 2001. Evaluation of fungicidal seed treatments for the control of rhizoctonia root rot of field pea in Alberta in 2001.

Abstracts and Papers in Refereed Journals

Bains, P.S., H.S. Bennypaul, D.R. Lynch, L.M. Kawchuk and C.A. Schaupmeyer. 2001. Rhizoctonia disease of potatoes (*Rhizoctonia solani*); fungicidal efficacy, cultivar susceptibility, and effect of rotation crops. American Journal of Potato Research (in press).

Bains, P.S., H.S. Bennypaul and R.J Howard. 2001. *In vitro* identification of fungicides effective against saskatoon (*Amelanchier alnifolia*) pathogens. Proceedings "Modern Fungicides and Antifungal compounds: 13th International Reinhardsbrunn Symposium, May 14-18th, 2001. Friedrichroda, Germany (accepted).

Blade, S.F., M.A. Olson and R.C. Yang. 2001. Nutrient concentrations and nutritive value of field pea (*Pisum sativum* L.) straw in south-central Alberta. Can. J. Plant Sci. 81 (No. 3): 419-423.

Blade, S. F. and R. Bjorklund. 2001. New opportunities for grain and silage faba beans in NC Alberta. Agri-Food 2000 abstract. Can. J. of Plant Science 81: 123-124.

Chang, K.F., R.J. Howard, B.D. Gossen and S.F. Hwang. 2001. Stem smut (*Ustilago hypodytes*) on intermediate wheatgrass in Canada. Plant Dis. 85: 96.

Chang, K.F., R.J. Howard and S.F. Hwang. 2001. First report of powdery mildew on Canada thistle in North America. Phytopathology 91:S14-15 (Abstr.).

Chang, K.F., Y. Yang, R.L. Conner, S.F. Hwang and R.J. Howard. 2001. Relationship of bean seed infection with anthracnose to disease development and seed microflora. Can. J. Plant Pathol.23: 196 (Abstr.).

Chang, K.F., S.F. Hwang, L.M. Kawchuk, G.D. Turnbull and R.J. Howard. 2001. Report of aster yellows phytoplasma in poker statice and Queen Anne's lace in Alberta. Can. J. Plant Pathol. 23: 184 (Abstr.).

Driedger, D.R. and P. Sporns. 2001. Development of an antibody against diosgenin and spiroaminoketal alkaloids. Food Agric. Immunol. 13: 33-38.

Driedger, D.R. and P. Sporns. 2001. Immunoaffinity sample purification and MALDI-TOF MS analysis of alpha-solanine and alpha-chaconine in serum. J. Agric. Food Chem. 49: 543-548.

El Hafid, R., S.F. Blade and Y. Hoyano. 2001. Seeding date and nitrogen fertilization effects on the performance of borage (*Borago officinalis* L.). Industrial Crop & Products (submitted for publication).

El Hafid, R., S.F. Blade and Y. Hoyano. 2001. Borage agronomy in the black soil zones of Alberta, Canada. *In* Proceedings of the "New Crops and New Uses: Strength in Diversity" conference. Atlanta, USA. November 10-13.

Gossen, B.D., S.R. Rimmer, and J.D. Holley. 2001. First report of resistance to benomyl fungicide in *Sclerotinia sclerotiorum*. Plant Dis. 85: 1206.

Hwang, S.F., D.A. Gaudet, G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Role of cutting frequency and genetic resistance in prevention of winter injury of alfalfa by the cottony snow mold pathogen. Phytopatholgy 91: S41 (Abstr.).

Hwang, S.F., B.D. Gossen, K.F. Chang, G.D. Turnbull and R.J. Howard. 2001. Effect of seed damage and metalaxyl seed treatment on pythium seedling blight and seed yield of field pea. Can. J. Plant Sci. 81: 509-519.

Hwang, S.F., B.D. Gossen, G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Method of seedbed preparation affects establishment and stand productivity of alfalfa. Can. J. Plant Pathol. 23: 198 (Abstr.).

Hwang, S.F., B.D. Gossen, G.D. Turnbull, K.F. Chang, R.J. Howard and A.G. Thomas. 2000. Seeding date, temperature, and seed treatment affect pythium seedling blight of field pea. Can. J. Plant Pathol. 22: 392-399.

Kawchuk, L.M., J. Hachey, D.R. Lynch, F. Kulcsar, G.v. Rooijen, D.R. Waterer, A. Robertson, E. Kokko, R. Byers, R.J. Howard, R. Fischer and D. Prüfer. 2001. Tomato Ve disease resistance genes encode cell surface-like receptors. Plant Biol. 98: 6511-6515.

Khadhair, A.-H., J.P. Tewari, R.J. Howard and V.H. Paul. 2001. Detection of aster yellows phytoplasma in false flax based on PCR and RFLP. Microbiol. Res. 156: 179-184.

Pruski, K., J. Nowak, S. K. Asiedu and Y. Leclerc. 2001. Managing seed potato tuber size. Proceedings Northeast Potato Technology Forum 2001. Charlottetown, P.E.I. pp. 30-33.

Pruski, K., P. Duplessis, T. Lewis, T. Astatkie and J. Nowak. 2001. Photoperiod and jasmonate effects on *in vitro* tuberization of potato cultivars (*Solanum tuberosum* L.). Potato Research (in press).

Ronald, P.S., R.G. St-Pierre and P.S. Bains. 2001. Resistance to *Entomosporium mespili* among cultivars of saskatoon, *Amelanchier alnifolia*. Canadian Journal of Plant Pathology 23:391-402.

Wang, H., K.F. Chang, S.F. Hwang, G.D. Turnbull and R.J. Howard. 2001. Soil-drench treatment with *Trichoderma* and fungicides to control fusarium root rot of coneflower. Can. J. Plant Pathol. 23: 209 (Abstr.).

Thesis

Pruski, K. 2001. Micropropagation technology in early phases of commercial seed potato production. PhD thesis. Department of Plant Sciences, Crop and Weed Ecology. Wageningen Agriculture University. Wageningen, The Netherlands. ISBN: 90-5808-499-X.

Extension Publications

Ampong-Nyarko, K. 2001. A summary of insect problems in bedding plant greenhouses. Greenhouse Coverings 01-3:10-12.

Ampong-Nyarko, K. and M. Mirza. 2001. Managing thrips in poinsettias. Greenhouse Coverings 01-4:2.

Ampong-Nyarko, K., M. Mirza and N. Gesckhe. 2001. Pest-free greenhouse as the foundation for effective pest management. Greenhouse Coverings. March.

Ampong-Nyarko, K., M. Mirza, and K. Fry. 2001. A summary of insect problems in bedding plant. Greenhouse Coverings. May.

Ampong-Nyarko, K. and M. Mirza. 2001. Managing thrips in poinsettias. Greenhouse Coverings. July.

Bains, P.S. 2001. Cytospora dieback and canker disease of saskatoon. Prairie Fruit Journal 8:3-4.

Bains, P.S. 2001. Managing poinsettia diseases. Poinsettia Production Guide. AAFRD publication.

Bains, P. and M. Mirza. 2001. Powdery mildew in bedding plants. Greenhouse Coverings 01-3:7.

Blade, S.F., P. Laflamme, T. Buss, L. Maskewich, R. El Hafid, C. Weeks, M. Williams and B. Lowrie. 2001. Industrial hemp production and marketing. A compact disc to be released shortly.

Hausher, L.G. 2001. Fruit Facts Bulletin (newsletter). Editor/Writer. CDCS, Brooks. Monthly.

Hausher, L.G. 2001. Albert Market Gardeners Association Newsletter. Contributor. Five issues/year.

Hausher, L.G. 2001. The Prairie Fruit Journal. Contributor/technical advisor. Four issues/year.

Johns, O., C. Murray, H. Childs, J. Quereshi, J. Wang and J. Hill. 2001. Perennial Trial Garden 1999-2001. Popular Brochure.

Lopetinsky, K., D. Bagdan, L. Billings and L. Bonik et al. 2001. Alberta Pulse Network Proceedings. AAFRD. June.

Lopetinsky, K. and S. Blade. 2001. Support for registration 2001–new pulse varieties. CDCN. Edmonton, AB. April.

Mirza, M., M. Younus, P.S. Bains and K. Ampong-Nyarko. Bedding plants production guidelines. CDCN-2001-GP1.

Mirza, M. 2001. Questions asked during January. Greenhouse Coverings 01-1:1-2.

Mirza, M. 2001. How growers are responding to the increase in natural gas prices. Greenhouse Coverings 01-1:2-3.

Mirza, M. 2001. Vegetable crop report. Greenhouse Coverings 01-2:1.

Mirza, M. 2001. Tomato crop destroyed by chlorine gas. Greenhouse Coverings 01-2:1.

Mirza, M. 2001. Phyton-27 is not just for bacteria any more. Greenhouse Coverings 01-2:2.

Mirza, M. and M.Younus. 2001. A review of bedding plant problems. Greenhouse Coverings 01-3:3-5.

Mirza, M. 2001. Unbelievable! Poinsettia cuttings are coming in..Greenhouse Coverings 01-4:1.

Mirza, M. 2001. Bitter cucumber fruit. Greenhouse Coverings 01-4:4.

Mirza, M. 2001. Blossom End Rot (BER) of tomatoes. Greenhouse Coverings 01-4:5.

Mirza, M. 2001. Do you want to know more about calcium? Greenhouse Coverings 01-4:5-6.

Mirza, M. and P. Bains. 2001. Pythium and Fusarium caused a significant crop loss in fall planted cucumbers. Greenhouse Coverings 01-5:1.

Mirza, M. 2001. Poinsettia diseases to watch for. Greenhouse Coverings 01-5:2.

Mirza, M. Poinsettias: Maintain proper pH in the growing medium otherwise expect problems. Greenhouse Coverings 01-5:2.

Mirza, M. 2001. Poinsettia: crop condition and current problems. Greenhouse Coverings 01-6:1.

Mirza, M. and K. Ampong-Nyarko. 2001. Getting ready for the next vegetable crop. Greenhouse Coverings 01-6:2.

Mirza, M. and N. Savidov. 2001. Care of vegetable seedlings. Greenhouse Coverings 01-6:3-4.

Mirza, M. 2001. Northern Crop Report. AGGA Newsletter. Spring and Summer Issue.

Mirza, M. and K. Ampong-Nyarko. 2001. Greenhouse cleaning - a few pointers for cleaning your greenhouse. AGGA Newsletter Winter Issue.

Mirza, M. 2001. Northern Crop Report. AGGA Newsletter Winter Issue.

Mirza, M. 2001. Greenhouse production of lettuce. Proceeding Mid-Atlantic Fruit and Vegetable Convention. Vol.1. pp 58-60.

Mirza, M. 2001. How we market greenhouse crops. Proceedings Mid-Atlantic Fruit and Vegetable Convention. Vol.1. pp. 61-62.

Mirza, M. 2001. How we manage a tomato crop. Proceedings Mid-Atlantic Fruit and Vegetable Convention. Vol. 1. pp. 63-64.

Murray, C.L., T.T. Pheh and N.G. Seymour. 2001. Evaluation woody plants for hardiness and landscape quality in Alberta. Ropin' the Web (update). <http://www.agric.gov.ab.ca/crops/trees/rwptp/index.html>

Murray, C.L., T.T. Pheh and N.G. Seymour. 2001. Nursery crops program, 2000. Crop Diversification Centre South. Brooks, AB. <http://www.agric.gov.ab.ca/crops/trees/trial2000/introduction.html>

Najda, H.G., C. Yoder and G. Monner. 2001. Cost and returns budget for irrigated perennial ryegrass—underseeded to durum wheat. AAFRD Agrifacts. Agdex 127/821-5. 2 pp.

Savidov, N. and M. Mirza. 2001. Maintenance and cleaning of drip irrigation systems at the end of season. Greenhouse Coverings 01-6:4.

Younus, M. and M. Mirza. 2001. Tomato and pepper seedlings suddenly die. Greenhouse Coverings 01-3:2-3.

Younus, M. 2001. Bedding plant round-up. Greenhouse Coverings 01-4:3-4.

Younus, M. and M. Mirza. 2001. Bedding plants: growing concerns. Greenhouse Coverings 01-3:5-7.

Younus, M. 2001. Micronutrient nutrition in bedding plants. Greenhouse Coverings 01-3:8-10.

Popular Articles

Ampong-Nyarko, K., B. Choban and J. Motta. 2001. Insect pests outlook for cole crops in 2001. Alberta Market Gardeners Association Newsletter. June.

Bains, P.S. and M. Mirza. 2001. Watch for bedding plant diseases at early stages. Agri-News. April 2. p.5.

Bains, P.S. and M. Mirza. 2001. Powdery mildew disease of poinsettias. Agri-News. October 8. p.5.

Chang, K.F. and S. Barkley. 2001. Seed treatments necessary for pulse crops. Agri-News. August 13. p.3-4.

Colter, D. 2001. Hive equipment inspection a primer and a refresher. Alberta Bee News. February. p. 8.

Colter, D. 2001. Remembering "Papa Joe". Alberta Bee News. February. p 12.

Colter, D. 2001. Hive equipment inspection a primer and a refresher. Alberta Bee News. March. p. 4.

Colter, D. 2001. Developing a strategy for AFB prevention and control. Alberta Bee News. April. p. 5.

Colter, D. 2001. Making divisions - divide your wintered colonies to create new hives. Alberta Bee News. May. p. 5.

Colter, D. 2001. Dividing to make new colonies. Alberta Bee News. August. p. 6.

Driedger, D.R. 2001. Green potatoes. Agri-News. May 7. p. 4.

El Hafid, R., S.F. Blade and Y. Hoyano. 2001. Borage agronomy in the black soil zones of Alberta. Kernels (submitted for publication).

Hausher, L.G. 2001. Growing berries for a growing berry market. Agri-News. January.

Hausher, L.G. 2001. Highlights of the IV International Strawberry Symposium. Fruit Facts. January-April.

Hausher, L.G. 2001. Strawberry research from other places. Fruit Facts. January-March.

Hausher, L.G. 2001. Highlights of the 5th North American Strawberry Conference. Fruit Facts. February-July.

Hausher, L.G. 2001. Fruit crop trials at CDCS. Fruit Facts 01-5. May.

Hausher, L.G. 2001. Alberta black currant producers field tour. Fruit Facts 01-6. June.

Hausher, L.G. 2001. Hort Congress update—Trade Show sold out. Fruit Facts 01-7. July.

Hausher, L.G. 2001. Highlights of the North American Strawberry Growers Association summer tour and visits to Kentville Research Station and strawberry plant nurseries. Fruit Facts 01-9. September-October.

Konschuh, M.N. 2001. Fresh market potato cultivar demonstration. Kernels. Vol. 3, Issue 3. September.

Lopetinsky, K. 2001. Tight pulse rotations a risky prospect. Seeding Today Magazine. September.

McKenzie, R.C. and R.H. McKenzie. 2001. Phosphorus and water quality. Grain News. February.

Mirza, M. and K. Ampong-Nyarko. 2001. Getting ready for the next vegetable crop. Greenhouse Coverings. November.

Mirza, M., K. Ampong-Nyarko and K. Fry. 2001. Greenhouse Pest Advisory Notes. Volume 1, Issue 1-8. http://www.agric.gov.ab.ca/crops/hort/advisory/01_vol1_iss8.html

Mirza, M. 2001. Echinacea may be new greenhouse crop. Top Crop Manager. February.

Mirza, M. 2001. Research under glass. Agri-News. February 26. p.5.

Mirza, M. 2001. Malfunctioning of unit heaters can lead to bedding plant problems. Agri-News. March 26. p.4.

Mirza, M. 2001. Using organic fertilizers in greenhouse crop production. Agri-News. April 16. p.2.

Mirza, M. and M. Younus. 2001. Small problems can result in poor quality greenhouse plants. Agri-News. April 30. p.4.

Mirza, M. and N. Chaudhary. 2001. Alberta greenhouse crops industry profile. Agri-News. August 6. p.2.

Mirza, M. and S. Blade. 2001. Canadian science students learn about greenhouse research at CDC North. Agri-News. September 11. p.3.

Mirza, M., Savidov, N., Bains, P.S., Ampong-Nyarko, K. and K. Fry. 2001. Greenhouse crops industry getting ready for next season. Agri-News. December 24. p.1.

Motta J. and K. Ampong-Nyarko. 2001. Flea beetle already attacking horticulture crops. Agri-News. May 21.

Murray, C.L. 2001. Touring nurseries in Montreal and Quebec City with the Western Nursery Growers Group. Prairie Landscape Magazine. Dec/Jan 2002. pp. 8-9.

Najda, H. 2001. Southern Alberta update on grass seed production. Forage Seed News. Fall. p.10.

Najda, H. and A. Kruger. 2001. Agronomic studies on seed production of perennial ryegrass under irrigation in southern Alberta. Forage Seed News. Winter. pp. 53-55.

Pruski, K. 2001. Native cherries of the prairies. The Gardener for the Prairies. August issue.

Tuckey, K. 2001. Beekeeper achievement award to Eric Abell. Alberta Bee News. January. p. 4.

Tuckey, K. 2001. Importation of Canadian bees into Alberta, 2001. Alberta Bee News. March. p. 7.

Tuckey, K. 2001. rAFB and YOU. Alberta Bee News. April. p. 4.

Tuckey, K. 2001. Moncton 2001 - snow and bee talks. Alberta Bee News. May. p. 3.

Tuckey, K. 2001. The year that was - 2000. Alberta Bee News. June. p. 9.

Tuckey, K. 2001. Collecting items. Alberta Bee News. July. p. 6.

Tuckey, K. 2001. A control for RAFB??? Alberta Bee News. August. p. 5.

Tuckey, K. 2001. Dates that stick in my mind. Alberta Bee News. August. p. 12.

Tuckey, K. 2001. rAFB. Alberta Bee News. October. p. 10.

Tuckey, K. 2001. Whose bees are those?????? Alberta Bee News. November. p. 3.

Tuckey, K. 2001. Alberta Review, 2001. Alberta Bee News. December. p. 12.

Books

Blade, S.F. 2001. Pulse Crops in Alberta. AAFRD. Agdex 142/20-1.

Blade, S.F. and A.E. Slinkard. 2001. International New Crop Development-The Canadian Experience. In "New Crops and New Uses: Strength in Diversity" (ed. J. Janick). ASHS Press. Alexandria, VA.

Blade, S.F. and R. El Hafid. 2001. New issues in borage agronomy. In "New Crops and New Uses: Strength in Diversity" (ed. J. Janick). ASHS Press. Alexandria, VA.

McKenzie, R.C. and S.A. Woods. 2001. Potential of precision farming with potatoes – a chapter in Precision Farming, a Global Perspective. A. Srinivasan Ed. Pub. by Haworth. *In* Press.

Posters

Chang, K.F., R.J. Howard and S.F. Hwang. 2001. First report of powdery mildew on Canada thistle in North America. The American Phytopathological Society, Mycological Society of American and Society of Nematology Joint Annual Meeting. Salt Lake City, Utah. August 28-29.

Chang, K.F., S.F. Hwang, D.A. Burke, R.J. Howard and M. Bandara. 2001. The occurrence and etiology of mint stolon rot in Alberta. Plant Pathology Society of Alberta (PPSA) Annual Meeting. Waterton Lakes National Park, AB. November 7-9.

Chang, K.F., Y. Yang, R.L. Conner, S.F. Hwang and R.J. Howard. 2001. Relationship of bean seed infection with anthracnose to disease development and seed microflora. The Canadian Phytopathological Society Annual Meeting. London, ON. June 12.

Chang, K.F., Y. Yang, S.F. Hwang and R.J. Howard. 2001. Biological control of *Sclerotinia sclerotiorum* on *Echinacea angustifolia*. PPSA Annual Meeting. Waterton Lakes National Park, AB. November 7-9.

Holley, J. 2001. Evaluation of a new disinfectant for the control of storage diseases. Potato Growers of Alberta Annual Meeting. Banff, AB. November 13-15.

Hwang, S.F., D.A. Gaudet, G.D. Turnbull, K.F. Chang and R.J. Howard. 2001. Role of cutting frequency and genetic resistance in prevention of winter injury of alfalfa by the cottony snow mold pathogen. The American Phytopathological Society, Mycological Society of American and Society of Nematology Joint Meeting. Salt Lake City, Utah. August 28-29.

Hwang, S.F., B.D. Gossen, G.D. Turnbull, K.F. Chang, R.J. Howard, and H. Yoder. 2001. Method of seedbed preparation affects establishment and stand productivity of alfalfa. PPSA Annual Meeting. Waterton Lakes National Park, AB. November 7-9.

Konschuh, M.N., J. Calpas, P. Bains and M. Nielsen. 2001. A comparison of biocontrol and chemical seed piece treatments for control of *Rhizoctonia* on potatoes. Potato Growers of Alberta Annual Meeting. Banff, AB. November 14-16.

Konschuh, M.N., M. Nielsen, C. Schaupmeyer, D. Driedger and L. Delanoy. 2001. Russet Burbank vine management in southern Alberta. Potato Growers of Alberta Annual Meeting. Banff, AB. November 14-16.

Lopetinsky, K., S.F. Blade, T. Buss, P. Laflamme, R. El Hafid, R. Bjorklund and N. Clark. 2001. Field pea/cereal mixed cropping for silage production. Western Canada Agronomy Workshop. Lethbridge, AB. July 4-6.

Lopetinsky K., S.F. Blade, S.F. Hwang and G. Ozipko. 2001. Field evaluation of ascochyta blight control with Bravo 500® on field pea in NW Alberta. Western Canada Agronomy Workshop. Lethbridge, AB. July 4-6.

Lopetinsky, K., S.F. Blade, P. Laflamme, T. Buss, R. Bjorklund, M. Olson, C. Wildschut and N. Clark. 2001. Evaluation of special purpose pea cultivars in Alberta. Western Canada Agronomy Workshop. Lethbridge, AB. July 4-6.

Lopetinsky, K. 2001. PBR (Plant breeders rights) field pea assessment. Alberta Pulse Growers-Zone 3 Annual Meeting. Westlock, AB. December 4.

Murray, C.L., T.T. Pheh and N.G. Seymour. 2001. Nursery crops research at CDC North and South. CDC North 50th Anniversary Open House. Edmonton, AB. July.

Su, H., S.F. Hwang, S.F. Blade, G.D. Turnbull, K.F. Chang, R.J. Howard, R. Bjorklund, T. Buss and K. Piquette. 2001. Screening of pea germplasms, lines and cultivars for resistance to powdery mildew and ascochyta blight. PPSA Annual Meeting. Waterton Lakes National Park, AB. November 7-9.

Wang, H., K.F. Chang, S.F. Hwang, G.D. Turnbull and R.J. Howard. 2001. Soil-drench treatment with *Trichoderma* and fungicides to control fusarium root rot of coneflower. The Canadian Phytopathological Society Annual Meeting. London, ON. June 12.

Wang, H., K.F. Chang, S.F. Hwang, G.D. Turnbull and R.J. Howard. 2001. Alfalfa foliar diseases: Occurrence and management. PPSA Annual Meeting. Waterton Lakes National Park, AB. November 7-9.

Wang, H., S.F. Hwang, K.F. Chang, G.D. Turnbull and R.J. Howard. 2001. Susceptibility of alfalfa cultivars to foliar disease pathogens and efficacy of fungicide foliar application. PPSA Annual Meeting. Waterton Lakes National Park, AB. Nov. 7-9.

Presentations at Professional Meetings, Conferences and Seminars

Ampong-Nyarko, K. 2001. Chemical control of greenhouse insect and mites. Greenhouse Vegetables Production Workshop. Redcliff, AB. August 28.

Ampong-Nyarko, K. 2001. Pest management through chemical means. Bedding Plants Production Workshop. February 15.

Bains, P.S. 2001. Early blight, rhizoctonia stem canker, and silver scurf diseases of potatoes. A seminar presented at Shihezi Vegetable Research Institute. Shihezi, China. June 27.

Bains, P.S. 2001. Soil-borne diseases of potatoes. A seminar presented at Vegetable Institute of Urumqi. Urumqi, China. June 21.

Bains, P.S., H.S. Bennypaul and R.J Howard. 2001. *In vitro* identification of fungicides effective against saskatoon (*Amelanchier alnifolia*) pathogens. Modern Fungicides and Antifungal compounds: 13th International Reinhardsbrunn Symposium, Friedrichroda, Germany. May 14-18.

Bandara M. and E. Russell. 2001. New opportunities in crop diversification. Agricultural Lenders Workshop. Old College. Olds, AB. May 28-June 1.

Blade, S.F., T. Buss, P. Laflamme and K. Lopetinsky. 2001. New cereal/field pea silage systems for western Canada. FarmTech 2001 Annual Meeting. Red Deer, AB.

Blade, S.F., T. Buss, P. Laflamme and K. Lopetinsky. 2001. New technologies for field pea disease reduction. FarmTech 2001 Annual Meeting. Red Deer, AB.

Blade, S.F., T. Buss, P. Laflamme and K. Lopetinsky. 2001. Evaluation of special purpose field pea cultivars for niche markets. FarmTech 2001 Annual Meeting. Red Deer, AB.

Blade, S.F. ,K. Lopetinsky, S.F. Hwang and G. Ozipko. 2001. Field evaluation of ascochyta blight control with Bravo 500™ on field pea. Western Canada Agronomy Workshop Proceedings Volume V: 154-156. Lethbridge, AB.

Blade, S.F. ,T. Buss, P. Laflamme and K. Lopetinsky. 2001. Can we grow niche field pea for new markets? Western Canada Agronomy Workshop Proceedings Volume V: 163-165. Lethbridge, AB.

Blade, S.F. 2001. Low-THC hemp: new potential for an old crop. Germany/Canada Fibrex 2001. Alberta Research Council. Edmonton, AB.

Chang, K.F. 2001. The occurrence of vegetable diseases and their research update in western provinces of Canada. WCPD Annual Meeting. Banff, AB. October 14-16.

Duplessis, P. 2001. Alberta's potato industry. Alberta Food Business Seminar. Osaka and Nagoya, Japan. June 4 & 6.

Duplessis, P. 2001. Alberta's high generation seed potato industry. Atlantic Plant Tissue Culture & Biotechnology Association Workshop. Fredericton, NB. July 31-August 1.

El Hafid, R., S.F. Blade and Y. Hoyano. 2001. Borage agronomy in the black soil zones of Alberta, Canada. New Crops and New Uses: Strength in Diversity International Conference. Atlanta, USA. November 13.

EL Hafid, R. 2001. Update on the CDCP research program. Research Updates in the Peace Region Workshop. Grande Prairie, AB. March 29.

EL Hafid, R. 2001. Organic farming: challenges and opportunities. Agricultural Board Services Tour. Manning and Kerg River, AB. July 10-11.

EL Hafid, R. 2001. Organic farming: back to the future. AAFC Scientists/AAFRD Soil and Crop Specialists Workshop. Beaverlodge, AB. November 27.

Hausher, L.G. 2001. Alberta fruit crops program and industry. Olds College. Olds, AB. December.

Hausher, L.G. 2001. Current research on fruit crops in Alberta. Olds College. Olds, AB. December.

Kerr, N. and S.F. Blade. 2001. Effect of variety, maturity and processing on hemp fiber properties. Germany/Canada Fibrex 2001. Alberta Research Council. Edmonton, AB.

McKenzie, R.C., S.A. Woods, S. Mathur, L. Hingley, and D. Fujimoto. 2001. Phosphorus and compost and potatoes. Alberta Soils Workshop. Lethbridge, AB. February.

McKenzie, R.C., T.W. Goddard, S.A. Woods, J. Rodvang and L. Hingley. 2001.site specific management of potatoes. Poster presentation. Site Specific Management Conference. Edmonton, AB. December.

McKenzie, R.C., S.A. Woods, L. Hingley. 2001. Site specific management of potatoes. Oral presentation and paper. Site Specific Management Conference. Edmonton, AB. December.

Mirza, M. 2001. Production of medicinal plants in greenhouses. University of Arizona, Department of Controlled Environment Agriculture, USA. January 19.

Mirza, M. 2001. Greenhouse vegetable production. Two Hills Mennonite Group. Two Hills, AB. January 23.

Mirza, M. 2001. Greenhouse production of lettuce. Mid-Atlantic Fruit and Vegetable Convention. Hershey, Pennsylvania. January 30-February 1.

Mirza, M. 2001. How to manage tomato crop. Mid-Atlantic Fruit and Vegetable Convention. Hershey, Pennsylvania. January 30- February 1.

Mirza, M. 2001. How we market greenhouse crops. Mid-Atlantic Fruit and Vegetable Convention. Hershey, Pennsylvania. January 30- February 1.

Mirza, M. 2001. Greenhouse heating systems. University of Alberta, Plant Science 357. Edmonton, AB. February 6.

Mirza, M. 2001. Alberta greenhouse crops industry. Olds College, Horticultural Club. Olds, AB. February 7.

Mirza, M. 2001. Greenhouse ventilation systems. University of Alberta, Plant Science 357. Edmonton, AB. February 13.

Mirza, M. 2001. Preparing a fertilizer program. University of Alberta, Plant Science 357. Edmonton, AB. February 27.

Mirza, M. 2001. Diagnosing nutritional disorders in greenhouse crops. University of Alberta, Plant Science 357. Edmonton, AB. March 15.

Mirza, M. 2001. Alberta greenhouse crops industry. University of Alberta. Plant Science 220. Edmonton, AB. October 26.

Mirza, M. 2001. Greenhouse crops production systems. University of Alberta. Plant Science 220. Edmonton, AB. November 2.

Naboris, K., R.G. Kachinowski, S.A. Woods and R.C. McKenzie. 2001. Field scale and temporal variability of nitrous oxide gas emissions with variable fertilizer application rates. Soc. Soil Sci. Ann. Meeting. Guelph, ON. August.

Naboris, K. R.G. Kochanoski, S.A. Woods and R.C. McKenzie. 2001. Field scale spatial and temporal variability of nitrous oxide gas emissions with various nitrogen fertilizer applications. Poster display. Specific Management Conference. Edmonton, AB.

Pruski, K., J. Nowak, S. K. Asiedu and Y. Leclerc. 2001. Managing seed potato tuber size. Northeast Potato Technology Forum 2001. Charlottetown, P.E.I.. March 21/22.

Pruski, K. 2001. Role of tissue culture propagation in local economies of two provinces in China. Atlantic Plant Tissue Culture & Biotechnology Association Workshop. Fredericton, NB. July 31/August 1. Abstract p.6.

Pruski, K. 2001. Micropropagation technology in early phases of commercial seed potato production. Atlantic Plant Tissue Culture & Biotechnology Association Workshop. Fredericton, NB. July 31/August 1. Abstract p. 15.

Pruski, K. 2001. Micropropagation technology in early phases of commercial seed potato production. PhD thesis seminar at the Wageningen Agriculture University. Wageningen, The Netherlands. October 31.

Presentations at Industry Meetings

Ampong-Nyarko, K. 2001. Studies in integrated pest control: strawberries, saskatoons and greenhouses. Alberta Horticultural Congress. Edmonton, AB. November 8-10.

Bains, P. S., H.S. Bennypaul and R.J. Howard. 2001. Identification of fungicides effective against cytospora dieback and canker disease of saskatoon (*Amelanchier alnifolia*). Alberta Horticultural Congress. Edmonton, AB. Nov. 8-10.

Bains, P.S., H.S. Bennypaul, D.R. Lynch, L.M. Kawchuk and C.A. Schaupmeyer. 2001. Rhizoctonia disease of potatoes (*Rhizoctonia solani*): fungicidal efficacy and cultivar susceptibility. Annual meeting of the Potato Growers of Alberta. Banff, AB. Nov. 14-16.

Bains, P.S. 2001. Development of late blight of in Alberta potato fields in 2000. PGA area meetings. Taber, AB. March 28. Nisku, AB. April 4.

Calpas, J., L. Delanoy, I. Evans, J. Holley, M. Konschuh, M. Nielsen, C. Schaupmeyer. 2001. BRR Workshop, Brooks, AB. July.

Chang, K.F. 2001. Cultivar reaction and bean seed treatment to control halo blight. Bean Growers Production Meeting (organized by Agricore). Burdett, AB. Feb. 6.

Chang, K.F. 2001. Seed and soil-borne diseases impacting pulses. Discover The Hidden Value of Seed Treatments Workshop. Medicine Hat College Brooks Campus. Brooks, AB. June 27.

Driedger, D.R. 2001. FPDC processing capabilities: Chokecherries. Alberta Fruit Growers' Society Berry Production Conference, Kananaskis, AB, February 24.

Driedger, D.R. 2001. Opportunities for processing horticultural crops. Intro into Growing and Selling Horticultural Crops Workshop. Two Hills, AB. January 23.

Hausher, L.G. 2001. Getting started into commercial fruit production. Intro into Growing and Selling Horticultural Crops Workshop. Two Hills, AB. January 23.

Hausher, L.G. 2001. Strawberry/raspberry/saskatoon production and marketing topics. Commercial Berry Production School. Red Deer, AB. February.

Hausher, L.G. 2001. The saskatoon industry: realities of the past — prospects for the future. FGSA Production Workshop. Kananaskis, AB. February.

Hausher, L.G. 2001. Strawberry/raspberry/saskatoon topics. Growing Berries for Fun and Profit Workshop. Whitehorse, YT. March.

Hausher, L.G. 2001. Black currants: where are we now? Alberta Horticultural Congress. Edmonton, AB. November.

Hausher, L.G. 2001. North American strawberry growers tour. Alberta Horticultural Congress. Edmonton, AB. November.

Holley, J. 2001. Potato diseases. Syngenta Grower Meeting and Field Day. Brooks, AB. July 4 and 6.

Howard, R.J. 2001. Bean seed treatment to control halo blight. Bean Growers Production Meeting (organized by Agricore). Taber, AB. Feb. 5.

Khadhair, A.H., P. Duplessis McAllister, K. Ampong-Nyarko and P.S. Bains. 2001. Potato Purple Top and Witches'-Broom Phytoplasma Diseases. Annual meeting of the Potato Growers of Alberta. Banff, AB. Nov. 14-16.

Konschuh, M., J. Calpas, P.S. Bains and M. Nielsen. 2001. A comparison of biocontrol and chemical seed piece treatments for control of Rhizoctonia on potatoes. Annual meeting of the Potato Growers of Alberta. Banff, AB. Nov. 14-16.

Konschuh, M.N. 2001. AAFRD potato research program. Maple Leaf Potatoes - Syngenta Potato Producer Workshop. Taber, AB. March 12.

Konschuh, M.N. 2001. Plot tour and description of *Rhizoctonia* trial. Syngenta Crop Protection Field Days. CDCS. Brooks, AB. June 20, 26, and 27; July 5 and 10.

Lopetinsky, K. et al. 2001. Summary of agronomy research priorities – National Pulse Strategy. Pulse Canada Research Workshop. November 18-20.

Lopetinsky, K., S. Strydhorst, M. Essensa and T. Wagner. 2001. Alberta Pulse Growers-Zone 3 research and demonstrations report. Alberta Pulse Growers-Zone 3 Annual Meeting. December 4.

Lopetinsky, K. 2001. New developments in Alberta pulse crops. Seed Technology Workshop. Olds College. Olds, AB. November 14-16.

Lopetinsky, K. and M. Olson et al. 2001. Weed control issues in pulse crops. Alberta Advisory Meeting. Edmonton, AB. November 7.

McKenzie, R.C., S.A. Woods, S. Mathur, L. Hingley and D. Fujimoto. 2001. Phosphorus and compost and potatoes. Potato Growers of Alberta breakfast meeting. Taber, AB. March.

McKenzie, R.C. 2001. Phosphorus and compost fertilization of potatoes. PGA meeting. Taber, AB. April.

McKenzie, R.C. 2001. Phosphorus compost and potatoes. Olds College Compost Conference. Olds, AB. May 3.

McKenzie, R.C. 2001. Field plots of phosphorus and compost experiments with potato. PGA meeting. Taber, AB. July.

McKenzie, R.C. 2001. Phosphorus and water quality. Intensive Livestock Operations hearings. Duchess, AB. September.

Mirza, M. 2001. Managing bedding plants. Alberta Greenhouse Growers Association workshop. Edmonton, AB. February 15.

Mirza, M. 2001. Managing greenhouse vegetable crops. Alberta Greenhouse Growers Association workshop. Redcliff, AB. August 28.

Mirza, M. 2001. Are you listening to what your plants are trying to tell you? Alberta Horticultural Congress. Edmonton, AB. November 8.

Mirza, M. 2001. If you want to grow good quality plants, then give them what they need. Alberta Horticultural Congress. Edmonton, AB. November 9.

Mirza, M. 2001. What's new in pesticides: Recently registered products. Alberta Horticultural Congress. Edmonton, AB. November 9. (talk given on behalf of Graeme Murphy, IPM specialist, Ministry of Agriculture, Food and Rural Affairs, Ontario)

Mirza, M. 2001. Increasing yields to offset greenhouse energy costs. Sask. Greenhouse Growers Association Convention. Saskatoon, SK. November 16.

Mirza, M. 2001. Cucumbers, tomatoes and peppers: from seeding to harvest. Sask. Greenhouse Growers Association Convention. Saskatoon, SK. November 17.

Mirza, M. 2001. Diagnosing problems on tomatoes, cucumbers and peppers. Sask. Greenhouse Growers Association Convention. Saskatoon, SK. November 17.

Mirza, M. 2001. Greenhouse energy conservation and plant growth. Sask. Greenhouse Growers Association Convention. Saskatoon, SK. November 17.

Murray, C.L. 2001. Nursery crops research in Alberta. Alberta Horticultural Congress. Edmonton, AB. November.

Najda, H.G. 2001. Grass seed production — the basics. Warburg Seed Cleaning Plant Annual Meeting. Warburg, AB. November.

Najda, H.G. and A. Kruger. 2001. Agronomic studies on seed production of perennial ryegrass under irrigation in southern Alberta. Canadian Alfalfa Seed & Forage Seed Conference. Saskatoon, SK. January.

Ragan, P. and M.N. Konschuh. 2001. Fresh Market Vegetable and Potato Producer Field Day. CDCS. Brooks, AB. July 31.

Tuckey, K. 2001. Bee act and disease. Alberta Beekeepers Association Bee Colony Disease Update. Edmonton, AB. February 26.

Tuckey, K. 2001. Alberta update. Beekeepers Field Day. Beaverlodge, AB. June 22.

Tuckey, K. 2001. Alberta review. Alberta Beekeepers Association Convention. Edmonton, AB. November 5.

Media Interviews

Bains, P.S. 2001. Seed piece treatments offer more marketable crop. Top Crop Manager Magazine. February.

Bains, P.S. 2001. Significance of the development of late blight disease of potatoes in kitchen gardens to Alberta potato industry. Call of the Land, CKUA. Edmonton, AB. August.

Bandara, M. 2001. Special crops diversification: opportunities in Alberta. The Brooks & County Chronicle. Vol 6. No 27. October 29.

McKenzie, R.C. 2001. Soil and water agronomy program and production of compost. The Brooks Bulletin.

McKenzie, R.C. and R.H. McKenzie. 2001. Phosphorus and water quality. The Brooks Bulletin. February.

Mirza, M. 2001. Research in greenhouse crops at CDCN. CKUA. Edmonton, AB. March 1.

Murray, C.L. 2001. Scientist on cutting edge of nursery crop research. The Brooks Bulletin. May 23.

Staff List

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Horticulture Unit (cont'd)

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W. Johnson, Dipl. Hort. ..... Vegetable Crops, CDCN

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C.J. Wildschut, Dipl. Hort. ..... Special Crops, CDCS

Departures

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Educational Leave

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S.A. Woods, B.Sc., M.Sc. ..... Soil and Water Agronomy, CDCS

Transfers

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Pest Prevention and Management Unit

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Transfers

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S. Milne ..... Irrigation Technician, CDCN
R. Williams ..... Senior Mechanic, CDCS
W. Wise ..... Farm Manager, CDCS

Departures

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G. Hooke, Journeyman Landscape Gardener ..... Chemical Applicator and Gardener, CDCN

Administrative Support Staff

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S.C. Day ..... Administrative Support (P/PT), CDCS
P. Fulton ..... Administrative Support, CDCN
L.I. Hansen ..... Officer Manager, CDCN
B.A. Humphreys ..... Receptionist/Timekeeper, CDCS
A. Moeller ..... Accountant, CDCS
C. Moore ..... Administrative Support, CDCN
V. Noel ..... Courier, CDCN
J.P. Petersen ..... Administrative Support/Human Resources, CDCS
C. Pugh ..... Administrative Support/Courier (TS), CDCS
M. Tanigami-Bunney ..... Administrative Support, CDCS

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H. Ellis, CGA ..... System Administrator, CDCS

Glossary

AAFC	Agriculture and Agri-Food Canada
AAFRD	Alberta Agriculture, Food and Rural Development
AARI	Alberta Agriculture Research Institute
AMGA	Alberta Market Gardeners Association
ARC	Alberta Research Council, Vegreville, Alberta
CDCN	Crop Diversification Centre North, Edmonton, Alberta
CDCP	Crop Diversification Centre Peace, Beaverlodge, Alberta
CDCS	Crop Diversification Centre South, Brooks, Alberta
GPS	Global Positioning System
PGA	Potato Growers of Alberta
MII	Matching Investment Initiative